R-3825-3
VOLUME I

TECHNICAL MANUAL

MAINTENANCE AND REPAIR

J-2 ROCKET ENGINE

(ROCKETDYNE)

CHANGE NOTICE

LATEST CHANGED PAGES SUPERSEDE THE SAME PAGES OF PREVIOUS DATE

Insert changed pages into basic publication. Destroy superseded pages.

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NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page.

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Upon receipt of the second and subsequent changes to this technical manual, personnel responsible for maintaining this publication in current status will ascertain that all previous changes have been received and incorporated. Action should be taken promptly if the publication is incomplete.

This page reflects the current status of the complete manual. All pages listed must be in the manual to make this publication current and complete.

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4-13 thru 4-14	0	Original
4-15 thru 4-16	7	31 Oct 72
4-17	0	Original
4-18 thru 4-19	7	31 Oct 72
4-20	0	Original
4-21	4	31 Aug 70
4-22	7	31 Oct 72
4-23	0	Original
4-24	4	31 Aug 70
4-25	7	31 Oct 72
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4-27	0	Original
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4-61	4	31 Aug 70
4-62	0	Original
4-63	4	31 Aug 70
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6-2	0	Original
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INTRODUCTION

This manual is one of the R-3825-series technical manuals prepared to provide official Rocketdyne field support documentation for the operation and maintenance of the J-2 Rocket Engine, Part Number 103826, Serial Numbers J-2062, J-2083, J-2087, J-2095, J-2103, J-2107, J-2139 through J-2147, and J-2149 through J-2152, and its related ground support equipment, designed and manufactured by Rocketdyne Division, Rockwell International, 6633 Canoga Avenue, Canoga Park, California 91304. The information in these manuals was prepared by Logistics Services Department of Rocketdyne.

The manuals are used to best advantage when each manual is current and complete (see figure 1) and the purpose and scope of each manual is known. The manuals in this series, and the nature of the data each provides, are found in the comments and support function chart.

1. J-2 MANUALS--THEIR SUPPORT FUNCTIONS.

The contents and support function chart lists all J-2 series technical manuals, describes the support function of each manual, and lists the section titles of each manual. The chart also explains how the technical data in each manual relates to the support of the engine and its ground support equipment throughout a normal engine flow, as well as during unscheduled maintenance tasks. Information appearing in one manual is not duplicated in another. Thus, information on the description, operation, and maintenance of ground support equipment is in R-3825-5. However, the instructions for servicing the engine using ground support equipment are in R-3825-3 and R-3825-1B.

Manual	Contents and Support Function	Section	Title
R-3825-1 J-2 Rocket Engine Data	This manual contains a description and theory of operation of the engine, its systems, and its components; mass properties and design load criteria, including engine weight, gimbaled mass, center of gravity, and moment of inertia for the basic engine and its accessories; and customer connections.	I	Description and Operation
		II through VII	Deleted
		VIII	Performance
		IX	Mass Properties and Design Load Criteria
		X	Electrical System Interface Data
		XI	Instrumentation System Interface Data
		XII	Customer Connections
R-3825-1B J-2 Rocket Engine Operating Instructions Supplement	This manual contains authorized field operating requirements that affect flight engines during their normal flow from engine receipt through vehicle launch, and those procedures recommended by Rocketdyne that support these requirements most effectively. All specific and general requirements for activities to be performed and acceptability criteria for these activities are included along with the limits, special constraints, safety precautions, and correct sequences required to satisfactorily accomplish the activities.	I	Operating Requirements
		II	General Requirements
		III	Operating Procedures

Manual	Contents and Support Function	Section and Title
R-3825-3, Volume I J-2 Rocket Engine Maintenance and Repair	This manual contains requirements and procedures for handling; component removal and installation; cleaning; post-maintenance test requirements; the safety precautions to be observed; and information on the tools, materials, electrical power, and pressurizing agents necessary to perform the tasks.	See table of contents for this volume.
R-3825-3, Volume II J-2 Rocket Engine Maintenance and Repair	This manual contains requirements and procedures for component bench testing and repair; the safety precautions to be observed; and information on the tools, materials, electrical power, and pressurizing agents necessary to perform the tasks.	I Air Filler Valve II Armored Harness III Augmented and Gas Generator Spark Igniter Cables IV Electrical Control Assembly V Flight Instrumentation Packages VI Fuel Turbopump VII Heat Exchanger VIII Helium Fill Check Valve IX Ignition Detector Probe X Insulation XI Integral Hydrogen-Helium Start Tank XII Mainstage OK Pressure Switch XIII Oxidizer Turbopump XIV Purge and Seal Drain Check Valves XV Solenoid Valves XVI Start Tank Discharge Valve XVII Start Tank Refill Check Valve Manifold 307599-41 XVIII Start Tank Support and Fill Valve XIX Thrust Chamber XX Transducers XXI Vent Port Check Valves

Manual	Contents and Support Function	Section and Title	
R-3825-4 J-2 Rocket Engine Illustrated Parts Breakdown	This manual contains related illustrations and columnar listings of all parts of the engine that can be replaced at field sites as determined by the maintenance concept; definitions and designations of source, maintenance, repairability, interchangeability, and usable on codes; information pertaining to retrofit modifications; identification of next-higher assemblies; and identification of reference designation numbers.	I II III	Introduction Group Assembly Parts List Numerical Index
R-3825-5, Volume I J-2 Rocket Engine Ground Support Equipment Maintenance and Repair	This manual contains a description of engine servicing, handling, and test equipment; procedures for performing maintenance and checkout tasks; and inspection and maintenance requirements tables.	I II III IV V VI VII VIII IX X XI XII XIII XIV XV	General Maintenance and Repair Thrust Chamber Throat Plug Kit G3120 Thrust Chamber Protective Pad 9016705 Electrical Checkout Console G1037 Flight Instrumentation Checkout Console G1035 Data Recorder Console G3121 Engine Test Plates; Adapters, and Tools Extended Range Vibration Safety Cutoff Set G1038 Pneumatic Console G3106 Pneumatic Flow Tester G3104 Simulator Panel 9024480-11 Components Test Console G3107 Automatic Inert Gas Arc Welding Set G3128 Single Head Special Tool Kit G3127 Propellant Utilization Valve Voltage Adjust and Monitoring Test Unit 9025664
R-3825-5, Volume II J-2 Rocket Engine Ground Support Equipment Maintenance and Repair	This manual contains a description of engine servicing, handling, and test equipment; procedures for performing maintenance and checkout tasks; and inspection and maintenance requirements tables.	I II III IV V	Miscellaneous Tools Gas Generator High-Low Temperature Cutoff Panel G1047 Outboard Engine Restrainer G4066 Film-Cooled Diffuser G4070 Components Adapter Set 9016796

Manual	Contents and Support Function	Section and Title	
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		VIII	Spark Monitor/Overspeed Cutoff Panel G1045
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		XIV	Hot-Gas Temperature Transducers NA5-27323T4 and NA5-27342T3
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		XVI	Thrust Chamber Diffuser Installing Tool Kit 9025144
		XVII	Proof-Test Weights
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		XXII	Engine Handler G4064
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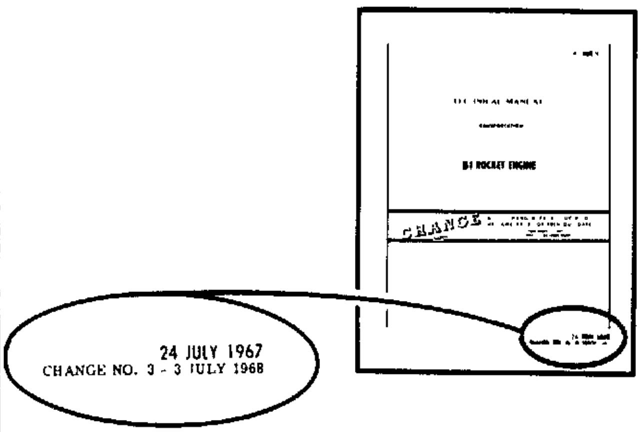
		XXXIII	Engine Components Installers

USE YOUR MANUAL ONLY IF CURRENT AND COMPLETE

Manuals that are not current and complete are not authoritative documents and are not to be used. The following outlines the method for determining whether your manual is current and complete.

A. DETERMINING CURRENCY. To be sure that yours is the latest issue of the manual, refer to Configuration Identification & Status Report , which is revised monthly and lists the technical manual numbers, titles, unincorporated supplements, and latest change or revision dates. Your manual must have a title page with the same or later date than the date shown in the Configuration Identification & Status Report. Your manual must also include the unincorporated supplements listed in the Configuration Identification & Status Report, or if your manual is later than shown in the report, the unincorporated supplements listed in the Manual Data Supplement Record in your manual. If your title page incorporates two dates as illustrated below, compare the change (lower) date. If your manual is not current, obtain a current copy through your technical manual supply system.

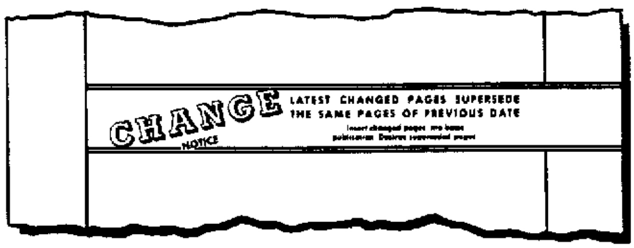


B. DETERMINING COMPLETENESS. To be sure that your manual is complete, make a page-by-page comparison of its pages to those listed in the List of Effective Pages. The List of Effective Pages, which shows the change status since the basic issue or last revision, is found on the alphabetically lettered page(s) immediately following the title page. All pages, except supplements, are listed with their issue dates. Manual pages that are dated must have the same date as that appearing in the List of Effective Pages for that page. Unchanged pages are listed as "original" and are not dated.

HOW TO KEEP YOUR MANUAL UP-TO-DATE

As design changes are made to the rocket engine and ground support equipment and better methods of maintenance are discovered, your manual is periodically changed, revised, or supplemented. The following steps will help you keep your manual up-to-date:

A. CHANGES. Updating by adding to or partially replacing existing pages is defined as a change. Changes can be identified by the change notice on the new title page.



To collate a change, refer to the Filing Instructions sheet issued with the manual and proceed as follows:

1. Remove the pages listed in the "Remove" column of the Filing Instructions sheet from the manual and destroy them. Do not concern yourself with the data on the opposite side of the deleted page since, if this date is not deleted, it is replaced in the change package.

2. Insert all pages listed in the "Insert" column of the Filing Instructions sheet in sequence. Pages with a suffix letter are inserted in alphabetical order following the page with the same basic number; for example, pages 3-14A, 3-14B, etc, follow page 3-14.

GEN-NASA-1A

Figure 1. How to Maintain Your Manual (Sheet 1 of 2)

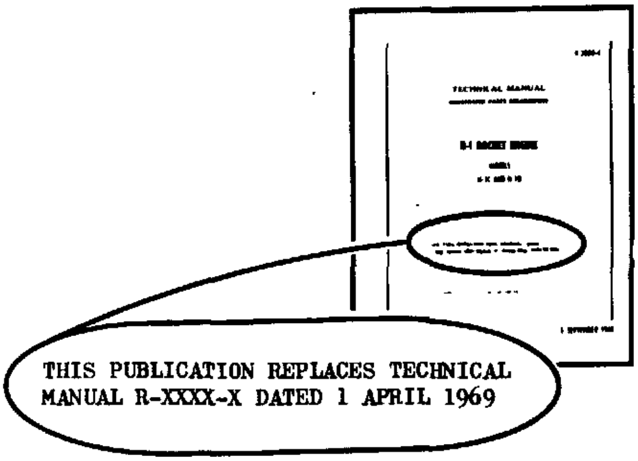
3. If you are unsure of the status of any page or pages, refer to the List of Effective Pages and make sure your manual contains pages (with the corresponding change dates) listed in the List of Effective Pages.

4. Remove manual supplements that have been incorporated.

NOTE

Incorporated supplements can be determined by reviewing the newly issued Manual Data Supplement Record.

B. REVISIONS. Updating by replacing all the existing pages of a manual is defined as a revision. Revisions can be identified by the replacement notice on the new title page.



To collate a revision, proceed as follows:

1. Remove and destroy all existing pages of your manual except Manual Data Supplements that have not been incorporated.

NOTE

Unincorporated supplements can be identified by reviewing the Manual Data Supplement Record supplied in the revision.

2. Insert the new pages in your cover.

C. SUPPLEMENTS. Updating that authorizes the addition to, or alteration of, the existing data in your manual is defined as a Manual Data Supplement. Information on how to insert supplements is found in the supplements.

HOW TO KEEP ABREAST OF THE LATEST CHANGES TO TECHNICAL DATA

Changes and/or additions to technical data are identified by a vertical bar (change bar) in the margin of the page adjacent to the changed data. A direct comparison between the new (identified by the change bar) and the old data will help you in identifying specific changes made.

GEN-NASA-2

Figure 1. How to Maintain Your Manual (Sheet 2 of 2)

2. CONFIGURATION IDENTIFICATION.

EQUIPMENT CONFIGURATION. The MD identification symbol and the equipment model designation indicate the configuration of the equipment and distinguish it from models incorporating different changes and from basic models. A basic, unchanged configuration of the equipment has no MD identification symbol. MD identification symbols are added as changes affecting configuration are incorporated into the equipment. The MD identification symbol is stamped on the MD plate, which is mounted near the engine nameplate.

MD IDENTIFICATION SYMBOLS. The MD identification symbol is a composite number representing all the changes affecting configuration (MD changes) that are incorporated or not incorporated into the equipment. The symbol represents a consecutively numbered series of MD changes. Any MD change, or series of MD changes, not incorporated is represented by an "X." Multi-digit numbers are underlined. Two figures together represent the limits of a series of incorporated MD changes. Figure 2 illustrates how MD changes incorporated in the equipment are represented by the MD identification symbol.

MANUAL REFERENCE. A reference that appears in the manual may refer to a series of MD changes or to an individual MD change; for example, "MD9" refers to MD1 through MD9, but "MD9 change" refer to the individual MD change 9. This latter type of reference, which is illustrated in figure 2, identifies separate sets of information required by differences in configuration. When an MD reference appears in this manual, examine the MD identification symbol on the equipment to determine which set of information is applicable.

3. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

All approved ECPs (Engineering Change Proposals) and associated MD numbers applicable to the equipment covered in this manual are listed in figure 3. The date in the last column is the publication date of the manual during which the change made by the ECP was incorporated. When N/A is entered, the ECP does not change the data in the manual. Engine configuration information and engine serial number allocation is in R-5788, Saturn J-2 Configuration Identification & Status Report.

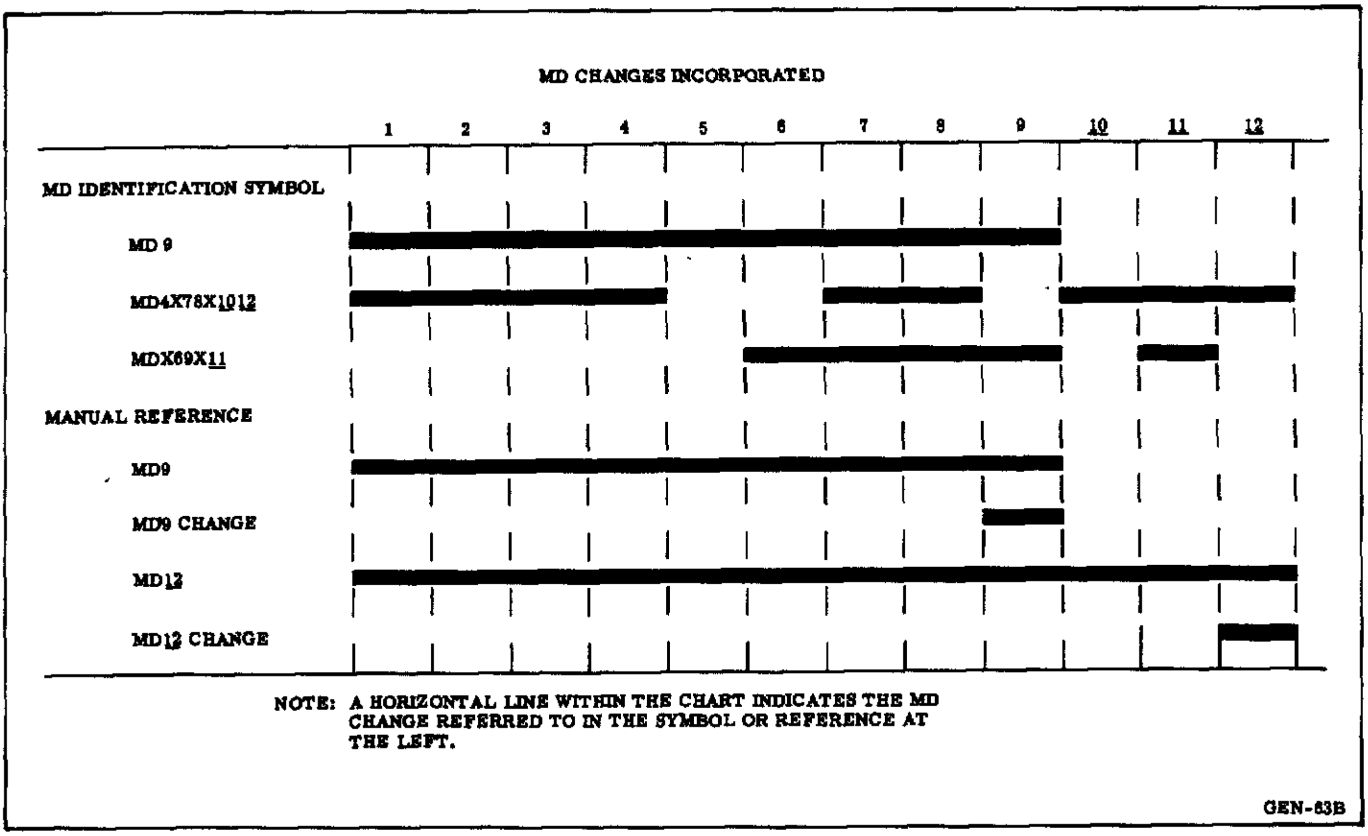


Figure 2. MD System

Approved ECP Number	MD Number	Incorporated in Manual Dated
J2-12	1	N/A
J2-13	1	N/A
J2-14	3	N/A
J2-15	1	N/A
J2-17	5	N/A
J2-18	6	9 July 1964
J2-19	5	9 July 1964
J2-20	64	20 April 1965
J2-20R1	--	N/A
J2-24	8	9 July 1964
J2-26	9	9 July 1964
J2-31	9	9 July 1964
J2-33	77	N/A
J2-36	1	N/A
J2-39	8	N/A
J2-41	2	N/A
J2-44R1	61	20 April 1965
J2-45	3	N/A
J2-46	5	N/A
J2-47	10	8 August 1965
J2-48	28	N/A
J2-51	16	N/A
J2-52	1	N/A
J2-55	7	25 January 1965
J2-57	11	25 January 1965
J2-62	9	19 October 1964
J2-63	33, 77	19 October 1964
J2-64	9	25 January 1965
J2-66	12, 26	9 July 1964
J2-67	14	9 July 1964
J2-69	33, 77	19 October 1964
J2-74	70	19 October 1964
J2-75	18	N/A
J2-76	56	N/A
J2-77	17	N/A
J2-78	20	19 October 1964
J2-79	55	25 January 1965
J2-80	11	19 October 1964
J2-81	9	9 July 1964
J2-82	70, 109	19 October 1964
J2-84	48	N/A
J2-85	8	25 January 1965
J2-86	26	9 July 1964
J2-87	23	N/A
J2-88	8	N/A
J2-90	8	N/A
J2-91	49	N/A
J2-92	8	N/A
J2-94	33, 77	9 July 1964
J2-95	20	19 October 1964
J2-96	24, 72	N/A
J2-97	25	25 January 1965
J2-98	22	N/A
J2-99	14	19 October 1964
J2-100	10	N/A
J2-101	27	25 January 1965
J2-102	38	19 October 1964
J2-103	8	N/A
J2-105	26, 31	N/A
J2-106	9	N/A
J2-107	42	N/A
J2-108	37	25 January 1965
J2-109	3	N/A
J2-110	36	25 January 1965
J2-112	13	25 January 1965
J2-113	34	N/A
J2-115	32	N/A
J2-117	9	N/A
J2-121	9	N/A
J2-122	8	N/A
J2-123	43	N/A
J2-124	60, 96	19 October 1964
J2-125	56	N/A
J2-126	3	19 October 1964
J2-127	21, 26	9 July 1964
J2-128	53	N/A
J2-129	40, 63	N/A
J2-130	3	N/A
J2-139	22, 23	19 October 1964
J2-140	41	19 October 1964
J2-141	9	25 January 1965
J2-146	9	N/A
J2-147	9	N/A
J2-151	11, 74	19 October 1964
J2-152	79	25 January 1965
J2-154	22, 23	19 October 1964
J2-157	44	N/A
J2-158	51	N/A
J2-159	22, 23	N/A
J2-160	47	N/A
J2-161R2	68	20 April 1965
J2-163	54, 75	N/A

Figure 3. Configuration Changes--Manual Effectivity (Sheet 1 of 6)

Approved ECP Number	MD Number	Incorporated in Manual Dated
J2-164	37	N/A
J2-166	45	N/A
J2-167	46	N/A
J2-172	59, 62	9 July 1965
J2-173	3	N/A
J2-174	57	20 April 1965
J2-181	9	N/A
J2-185	80	N/A
J2-186	69	N/A
J2-188	3	N/A
J2-191	64	25 January 1965
J2-191R1	--	N/A
J2-195	88	15 March 1966
J2-195R1	--	N/A
J2-195R2	--	N/A
J2-195R3	111	N/A
J2-195R4	--	N/A
J2-196	9	25 January 1965
J2-198	3	N/A
J2-199	97	N/A
J2-200	23	N/A
J2-202	37	25 January 1965
J2-203	66, 67	N/A
J2-204	56	N/A
J2-207	--	25 January 1965
J2-218	56	N/A
J2-226	71	N/A
J2-227	99, 104	N/A
J2-229	108	N/A
J2-229R1	--	N/A
J2-232	9	N/A
J2-235	58	21 June 1965
J2-236	72	N/A
J2-240	3	19 October 1964
J2-241	86	25 January 1965
J2-243	19	25 January 1965
J2-246	3	N/A
J2-247	76	N/A
J2-248	108	20 April 1965
J2-249	84	N/A
J2-250	87	N/A
J2-251	78	N/A
J2-252	56, 93, 94	N/A
J2-254	88	20 April 1965
J2-254R1	--	N/A
J2-254R2	--	N/A
J2-254R3	--	N/A
J2-254R4	91	N/A
J2-255	88	15 March 1966
J2-255R1	--	N/A
J2-255R2	--	N/A
J2-255R3	187	N/A
J2-255R4	--	N/A
J2-255R5	--	N/A
J2-257	9	N/A
J2-259	64, 92	25 January 1965
J2-260	38, 82, 85	19 October 1964
J2-261	83	19 October 1964
J2-268	9	N/A
J2-271R2	186	N/A
J2-271R3	--	N/A
J2-280	56	20 April 1965
J2-281	9	N/A
J2-283	102	19 October 1964
J2-284	101	N/A
J2-285	58	N/A
J2-286	3	N/A
J2-287	9	N/A
J2-288	3	N/A
J2-289	9	N/A
J2-290	9	N/A
J2-293	105	25 January 1965
J2-294	103	25 January 1965
J2-296	35	25 January 1965
J2-296R1	--	N/A
J2-298	50, 129	21 June 1965
J2-298R1	--	N/A
J2-300	107	N/A
J2-303	56	N/A
J2-306	9	N/A
J2-307	9	N/A
J2-308	56	N/A
J2-310	137	N/A
J2-310R1	--	N/A
J2-310R2	--	N/A
J2-312	9	N/A
J2-313	119	N/A
J2-314	113	20 April 1965
J2-315	70	21 June 1965
J2-316	19	25 January 1965
J2-317	9	20 April 1965
J2-318R1	153	N/A
J2-319	123	N/A
J2-319R1	--	N/A
J2-319R2	--	N/A
J2-320	100	21 June 1965
J2-320R1	--	N/A
J2-321	118	N/A
J2-322	116	N/A
J2-329	133	N/A

Figure 3. Configuration Changes--Manual Effectivity (Sheet 2 of 6)

Approved ECP Number	MD Number	Incorporated in Manual Dated	Approved ECP Number	MD Number	Incorporated in Manual Dated
J2-329R1	--	N/A	J2-387R1	--	N/A
J2-329R2	338	N/A	J2-387R2	--	N/A
J2-330	88	N/A	J2-387R3	--	N/A
J2-331R1	117	N/A	J2-387R4	--	N/A
J2-332	9	N/A	J2-388	166	16 November 1965
J2-333	141	N/A	J2-389R1	144	N/A
J2-333R1	--	N/A	J2-389R2	--	N/A
J2-338	136	N/A	J2-390	143	N/A
J2-340	9	20 April 1965	J2-391R1	88	21 June 1965
J2-341	120	20 April 1965	J2-394	148	N/A
J2-345R1	56, 125, 126	N/A	J2-394R1	--	N/A
			J2-395	146	N/A
J2-347	121	N/A	J2-395R1	--	N/A
J2-348	122	20 April 1965	J2-396	147	N/A
J2-350	15	N/A	J2-397	156	15 March 1966
J2-350R1	--	N/A	J2-398	182	N/A
J2-351	124	N/A	J2-398R1	--	N/A
J2-351R1	--	N/A	J2-399R2	163, 167	16 November 1965
J2-352	56	N/A	J2-399R3	202	N/A
J2-358	64	N/A	J2-401	152	N/A
J2-359	140	N/A	J2-401R2	--	N/A
J2-359R1	--	N/A	J2-403	157	N/A
J2-360	139	N/A	J2-403R2	--	N/A
J2-360R1	--	N/A	J2-404	88	N/A
J2-360R2	--	N/A	J2-405R2	237	N/A
J2-361	30, 127	21 June 1965	J2-407	88	N/A
J2-362	131	N/A	J2-408	155	21 June 1965
J2-363	138	N/A	J2-408R1	227	N/A
J2-363R1	--	N/A	J2-409	166	8 August 1965
J2-364	132	N/A	J2-409R1	--	N/A
J2-365	142	8 August 1965	J2-409R2	--	N/A
J2-366	128	N/A	J2-410	160	N/A
J2-367	70	N/A	J2-410R1	--	N/A
J2-368	130	N/A	J2-412	159	N/A
J2-368R1	--	N/A	J2-413	161	N/A
J2-369	151	N/A	J2-413R1	--	N/A
J2-369R1	--	N/A	J2-414	174	16 November 1965
J2-369R2	--	N/A	J2-414R1	--	N/A
J2-369R3	--	N/A	J2-414R2	--	N/A
J2-369R4	--	N/A	J2-415	170	15 March 1966
J2-370	150	N/A	J2-415R1	--	N/A
J2-370R1	--	N/A	J2-415R2	199, 200	N/A
J2-370R2	280, 281	N/A	J2-415R3	339	N/A
J2-371	70	N/A	J2-416	164	16 November 1965
J2-372	134	N/A	J2-416R1	165	N/A
J2-376	135	N/A	J2-417	173	N/A
J2-380	136	N/A	J2-419	168, 169	16 November 1965
J2-382	136	N/A	J2-421	172	15 March 1966
J2-383	158	16 November 1965	J2-421R1	--	N/A
J2-383R1	--	N/A	J2-422	171	N/A
J2-387	149, 154	16 November 1965	J2-423	--	N/A

Figure 3. Configuration Changes--Manual Effectivity (Sheet 3 of 6)

Approved ECP Number	MD Number	Incorporated in Manual Dated	Approved ECP Number	MD Number	Incorporated in Manual Dated
J2-424	--	N/A	J2-471R1	--	N/A
J2-426	185	N/A	J2-471R2	228	N/A
J2-428	194	15 March 1966	J2-472	193	N/A
J2-429	185	N/A	J2-474	215	17 May 1966
J2-430	172	15 March 1966	J2-474R1	--	N/A
J2-430R1	--	N/A	J2-474R2	--	N/A
J2-430R2	--	N/A	J2-474R3	--	N/A
J2-430R3	--	N/A	J2-474R4	231	N/A
J2-431	177	15 March 1966	J2-474R5	245	N/A
J2-431R1	--	N/A	J2-475	--	N/A
J2-431R2	--	N/A	J2-475R1	--	N/A
J2-432	176	N/A	J2-475R2	--	N/A
J2-433	178	N/A	J2-476	196	5 June 1967
J2-434	180, 181	15 March 1966	J2-476R1	--	N/A
J2-435	179	N/A	J2-476R2	--	N/A
J2-435R1	--	N/A	J2-476R3	--	N/A
J2-437	192	17 August 1966	J2-477R1	239, 310	N/A
J2-437R1	246	N/A	J2-477R2	--	N/A
J2-437R2	--	N/A	J2-479	206, 232	N/A
J2-438	185	N/A	J2-479R1	--	N/A
J2-440	201	N/A	J2-479R2	--	N/A
J2-445	172	N/A	J2-479R3	--	N/A
J2-449	183	N/A	J2-481	217	N/A
J2-449R1	--	N/A	J2-482R1	222	N/A
J2-451	172, 206	15 March 1966	J2-483	224, 225	17 August 1966
J2-452	184	N/A	J2-483R1	--	N/A
J2-455	188	N/A	J2-483R2	--	N/A
J2-455R1	--	N/A	J2-483R3	292	N/A
J2-455R2	198	N/A	J2-483R4	--	N/A
J2-455R3	--	N/A	J2-484	197	N/A
J2-458	191	15 March 1966	J2-485	--	N/A
J2-458R1	--	N/A	J2-488R1	208	N/A
J2-459	205	N/A	J2-489R1	185	N/A
J2-459R1	--	N/A	J2-489R2	--	N/A
J2-459R2	--	N/A	J2-492R2	--	N/A
J2-461	204	17 August 1966	J2-492R3	223	17 August 1966
J2-461R1	--	N/A	J2-493	185	N/A
J2-461R2	--	N/A	J2-494	210	17 August 1966
J2-463	189	N/A	J2-495	207	N/A
J2-465	190	N/A	J2-496	203	N/A
J2-465R1	334	N/A	J2-497	213	17 August 1966
J2-466R1	239	17 August 1966	J2-497R1	--	N/A
J2-466R2	310	N/A	J2-499	--	N/A
J2-467	212	N/A	J2-499R1	--	N/A
J2-468	172	N/A	J2-499R2	--	N/A
J2-468R1	--	N/A	J2-500	209	N/A
J2-469	195	N/A	J2-501	--	N/A
J2-469R1	--	N/A	J2-501R1	--	N/A
J2-470	211	N/A	J2-505	214	17 August 1966
J2-470R1	319	N/A	J2-507	226	N/A
J2-471	212	N/A	J2-507R1	--	N/A

Figure 3. Configuration Changes--Manual Effectivity (Sheet 4 of 6)

Approved ECP Number	MD Number	Incorporated in Manual Dated
J2-510	218	N/A
J2-511	219	17 August 1966
J2-511R1	--	N/A
J2-513	221	17 August 1966
J2-513R1	--	N/A
J2-514	--	N/A
J2-522	--	N/A
J2-522R1	--	N/A
J2-522R2	--	N/A
J2-523	233	17 August 1966
J2-524	229	2 March 1967
J2-525	234	5 June 1967
J2-525R1	--	N/A
J2-527	238, 248, 250, 290, 341	N/A
J2-527R1	--	N/A
J2-527R2	--	N/A
J2-527R3	--	N/A
J2-528	--	N/A
J2-528R1	--	N/A
J2-529	230	17 August 1966
J2-531	243	N/A
J2-532	270	N/A
J2-532R1	--	N/A
J2-538	244	5 June 1967
J2-538R1	--	N/A
J2-540	240	N/A
J2-541	--	N/A
J2-541R1	--	N/A
J2-542	242	N/A
J2-544	236	N/A
J2-545	235	5 June 1967
J2-546R1	243	N/A
J2-547	241	N/A
J2-547R1	--	N/A
J2-547R2	--	N/A
J2-548	237	N/A
J2-549	247	N/A
J2-550	262	11 July 1968
J2-551	276, 277	5 June 1967
J2-551R1	--	N/A
J2-552	251, 252	5 June 1967
J2-552R2	--	N/A
J2-553	254	5 June 1967
J2-553R1	347	N/A
J2-555	264	N/A
J2-556	--	N/A
J2-557	249	2 March 1967
J2-558	261, 258	N/A
J2-558R1	321	N/A
J2-559	--	N/A
J2-560	--	5 June 1967
J2-561	273	N/A
J2-564	253	N/A
J2-566	243	N/A
J2-566R1	--	N/A
J2-567	275	N/A
J2-567R1	--	N/A
J2-568	271	N/A
J2-570	294	N/A
J2-571R1	239	N/A
J2-575	256, 267, 278	5 June 1967
J2-575R1	--	N/A
J2-575R2	--	N/A
J2-575R3	--	N/A
J2-575R4	--	N/A
J2-575R5	--	N/A
J2-576	--	N/A
J2-577	--	N/A
J2-577R1	--	N/A
J2-577R2	--	N/A
J2-577R3	--	N/A
J2-580R1	--	N/A
J2-581	257, 318	2 March 1967
J2-581R1	--	N/A
J2-581R2	--	N/A
J2-581R3	--	N/A
J2-582	259	5 June 1967
J2-587	291	N/A
J2-588	263, 274	14 February 1968
J2-588R1	--	N/A
J2-588R2	--	N/A
J2-588R3	355	N/A
J2-589	--	N/A
J2-590	260	N/A
J2-590R1	--	N/A
J2-590R2	--	N/A
J2-590R3	--	N/A
J2-590R4	--	N/A
J2-590R5	--	N/A
J2-592	272	5 June 1967
J2-594	268, 269, 279, 282, 296, 313, 314, 315	5 June 1967
J2-594R1	--	N/A
J2-594R2	--	N/A
J2-594R3	--	N/A
J2-598	266	N/A
J2-599	265	5 June 1967

Figure 3. Configuration Changes--Manual Effectivity (Sheet 5 of 6)

Approved ECP Number	MD Number	Incorporated in Manual Dated
J2-599R1	--	N/A
J2-599R2	--	N/A
J2-600	239	N/A
J2-601	283	N/A
J2-601R1	--	N/A
J2-602	284, 285	5 June 1967
J2-602R1	--	N/A
J2-603	286	14 February 1968
J2-603R1	--	N/A
J2-603R2	--	N/A
J2-604	--	N/A
J2-605	287	4 October 1967
J2-606	324	N/A
J2-606R1	--	N/A
J2-607R1	288, 289, 297	N/A
J2-607R2	298, 299, 305, 306, 307, 308, 309	N/A
J2-608	300	N/A
J2-612	293	4 October 1967
J2-612R1	--	N/A
J2-613	--	N/A
J2-614	--	N/A
J2-616	303, 304	N/A
J2-618	270	N/A
J2-620	295, 323	14 February 1968
J2-620R1	301, 302, 322	N/A
J2-620R2	--	N/A
J2-620R3	--	N/A
J2-621	311, 312	14 February 1968
J2-624	316, 317, 320	14 February 1968
J2-624R2	342, 351	N/A
J2-627	--	N/A
J2-631	325	N/A
J2-632	--	N/A
J2-633	340, 349, 350	N/A
J2-634R1	--	N/A
J2-636	333	11 July 1968
J2-636R1	--	N/A
J2-637	335	11 July 1968
J2-640	336	N/A
J2-640R1	--	N/A
J2-641	348	N/A
J2-642	--	N/A
J2-643	327, 328, 329, 330, 331, 332	11 July 1968
J2-643R1	--	N/A
J2-643R2	--	N/A
J2-645	--	N/A
J2-646	337	N/A
J2-647	343	6 June 1969
J2-647R1	--	N/A
J2-649	--	N/A
J2-650	--	N/A
J2-651	--	N/A
J2-652	--	N/A
J2-653R2	--	N/A
J2-654	346	N/A
J2-655	--	N/A
J2-656	354	N/A
J2-657	353	N/A
J2-657R1	--	N/A
J2-657R2	--	N/A
J2-659	358	N/A
J2-662	360	N/A
J2-666	359	N/A
J2-666R1	--	N/A
J2-666R3	--	N/A
J2-668	361	N/A
J2-668R1	361	N/A
J2-671	--	N/A
J2-672	--	N/A
J2-675	362	N/A
J2-688	--	N/A
J2-689	365, 366	2 February 1971
J2-689R1	--	N/A
J2-689R2	371	N/A
J2-689R3	--	N/A
J2-694	363	5 March 1970
J2-694R1	--	N/A
J2-694R2	373, 374	N/A
J2-694R3	375	24 February 1972
J2-695	364	5 March 1970
J2-697	--	N/A
J2-698	--	N/A
J2-700	370	N/A
J2-704	372	24 February 1972
J2-708R1	380, 381	N/A
J2-710R2	382	N/A
J2-711	376	24 February 1972
J2-714	377, 378, 379	24 February 1972
J2-714R1	--	31 October 1972

Figure 3. Configuration Changes--Manual Effectivity (Sheet 6 of 6)

4. ABBREVIATIONS.

The following abbreviations may appear throughout this manual:

ASI	Augmented spark igniter
ECA	Electrical control assembly
EMR	Engine mixture ratio
FI	Flight instrumentation
GG	Gas generator
HB	Huntington Beach (McDonnell-Douglas Corporation)
Hz	Hertz (frequency in cycles per second)
KSC	Kennedy Space Center
MFV	Main fuel valve
mm Hg	Millimeters of mercury (vacuum)
MOV	Main oxidizer valve
MTF	Mississippi Test Facility (NASA)
NASA	National Aeronautics and Space Administration
NPSH	Net positive suction head
OTBV	Oxidizer turbine bypass valve
PU	Propellant utilization
SAC/MDAC	Sacramento Test Site (McDonnell-Douglas Corporation)
SB	Seal Beach (Space Division)
SIC	Spark igniter cable
STDV	Start tank discharge valve
VAB	Vertical Assembly Building (KSC)
VSC	Vibration safety cutoff

SECTION I

GENERAL MAINTENANCE AND REPAIR

1-1. SCOPE. This section contains general maintenance and repair information to support sections III, IV, V, and VI of this volume and the component repair procedures in R-3825-3, Volume II. All parts required for maintenance-level support of the engine are listed in R-3825-4.

1-2. <u>SAFETY PRECAUTIONS.</u>

NOTE

When performing work specified in this manual, all local safety and health directives must be complied with. It is assumed these directives are in compliance with the Occupational and Safety Health Act. When local safety and health directives are more stringent than those specified in this manual, the local directives will prevail.

1-3. Warnings and cautions are used throughout the text to indicate potentially dangerous steps. These warnings and cautions must be strictly observed by personnel performing the procedures. Specific precautions to follow are listed when a task involves working with potentially dangerous materials or hazardous conditions. The following examples explain warnings and cautions:

WARNING

A warning indicates a procedure or practice that, if not followed correctly, can cause injury or death.

CAUTION

A caution indicates a procedure or practice that, if not followed correctly, can cause damage to equipment.

1-4. ELECTRICAL SYSTEMS. The following precautions must be taken by personnel working with an electrical system.

WARNING

Connecting or disconnecting electrical connectors without turning off electrical power can result in injury to personnel and damage to equipment.

a. Make sure electrical power to engine is off before working on electrical components or cables.

b. Make sure circuit breaker for facility electrical outlet and all switches on electrical equipment are in off or deenergized position before connecting a power source to electrical equipment.

c. Do not leave controls unattended when an electrical system is energized.

d. Ground engine and each console with separate ground cables to a common ground point.

WARNING

Applying electrical power to the engine when connecting or disconnecting igniter cables or when igniter cables are disconnected can cause electrical arcing resulting in injury to personnel and damage to equipment.

e. Make sure engine spark igniter cables are installed before turning on engine power.

1-5. PRESSURIZED SYSTEMS. The following precautions must be taken by personnel working with high-pressure gases:

WARNING

Removing fittings, parts, or components from a pressurized system can result in injury to personnel and damage to equipment.

a. Make sure engine systems are depressurized before tightening or loosening any fitting or removing any part or component.

b. Make sure test equipment hoses or lines connected to components are depressurized before disconnecting.

c. Do not leave controls unattended when system is pressurized.

d. Secure all test hoses connected between test equipment, facility, or component under test, to prevent whipping if accidentally disconnected or in event of line failure.

e. Wear safety glasses or face shield when working on a pressurized system.

f. Make sure connections on all system components have full thread engagement.

g. Follow specified requirements for gasket sealants and lubricants.

WARNING

The use of contaminated parts in a liquid oxygen system can cause an explosion, resulting in serious injury to personnel and damage to equipment.

h. Install only parts cleaned for propellant service in engine propellant systems.

i. Protect all openings against entry of foreign material when a part or component is removed.

j. Restrain thrust chamber on stage-installed engines when pressurizing either the fuel or oxidizer (propellant) system with the remaining propellant system depressurized, to prevent gimbaling of engine.

1-6. THRUST CHAMBER ENTRY. The following precautions must be observed when entering the thrust chamber on stage-installed engines and engines installed in static test stand.

a. Take necessary precautions to prevent inadvertent pressurant or propellant admission into thrust chamber.

WARNING

Helium may be trapped in the thrust chamber. A self-contained air-breathing apparatus must be used to prevent injury or death to personnel.

b. Breathing apparatus must be worn when entering thrust chamber.

c. The buddy system must be used when personnel enter the thrust chamber.

d. Ladders used in thrust chamber must be adequately supported and have protective padding, to prevent damaging thrust chamber tubes.

NOTE

When available, the internal access platform (refer to R-3825-5) should be used for thrust chamber entry.

1-7. CLEANING SOLVENTS. Although cleaning solvents are considered the least hazardous of solvents available, specific uses of each solvent require special precautions, as stated in each applicable procedure. Improper use of a solvent can cause injury to personnel or damage to equipment. Cleaning solvents must not contact integral hydrogen-helium start tank during engine maintenance. Solvents can cause deterioration of the start tank insulation.

a. Trichloroethylene and trichloroethane are toxic solvents but are nonexplosive and nonflammable. At high temperatures (above 248°F) these solvents decompose releasing hydrochloric acid and between 950° and 1,750°F, deadly phosgene gas. Observe the following safety precautions when using trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or trichloroethane ST0210GB002 (Rocketdyne), or equivalent:

(1) Avoid excessive inhalation of trichloroethylene or trichloroethane vapors. These solvents even at room temperature, give off fumes which under prolonged inhalation can produce narcotic effects on the nervous system. Repeated overexposure results in an accumulation of effects.

(2) Do not allow these solvents to contact skin for prolonged periods, since they can be absorbed. The liquid chemically dries skin, leaving it susceptible to infection.

(3) Wear breathing apparatus while working with these solvents in confined or unventilated areas.

(4) Wear safety glasses or a face shield while handling these solvents.

(5) Do not expose trichloroethylene to excessive heat.

b. Observe the following safety precautions when using cleaning compound (MIL-C-81302), or cleaning solvent (MSFC-SPEC-237).

(1) Avoid excessive inhalation of vapors of cleaning compound or solvent since it may cause headaches, dizziness, sleepiness, or unconsciousness due to the oxygen-deficient atmosphere.

(2) Do not allow cleaning compound or solvent to contact skin for prolonged periods. The liquid chemically dries the skin, leaving it susceptible to infection.

(3) Wear safety glasses or face shield when using cleaning compound or solvent.

(4) Wear a breathing apparatus when using cleaning compound or solvent in confined or unventilated areas.

(5) Do not subject cleaning compound or solvent to excessive temperatures.

c. Observe the following safety precautions when using isopropyl alcohol (Federal Specification TT-I-735), or equivalent:

(1) Avoid excessive inhalation of vapors or isopropyl alcohol, since prolonged inhalation may cause slight intoxication.

(2) Wear breathing apparatus when using isopropyl alcohol in confined or unventilated areas.

(3) Use a minimum amount of isopropyl alcohol consistent with performing the task because of its low vaporizing qualities.

(4) Wear safety glasses or face shield when using isopropyl alcohol.

(5) Do not use isopropyl alcohol near source of ignition, heat, or open flame.

d. Observe the following safety precautions when using drycleaning solvent (Federal Specification P-D-680), or equivalent:

(1) Do not use drycleaning solvent near source of ignition, heat, or open flame.

(2) Wear safety glasses or face shield when using drycleaning solvent.

(3) Drycleaning solvent must be kept from areas that contact liquid oxygen.

1-7A. ACIDS. Chromium trioxide (Federal Specification O-C-303), nitric acid (Federal Specification O-N-350), and sulfuric acid (Federal Specification O-S-809) are hazardous materials. Iridite 14-2 powder (Allied Research Products) and Alodine 1200 powder (Amchem Products) become acid in solution, and the precautions applying to other acids must be observed. Acids in either concentrated or diluted liquid form will soak through clothes causing severe burns, dissolve metals, give off harmful vapors, generate explosions, and cause fires upon contact with combustible material. The following safety precautions must be taken by personnel handling acids:

a. Wear rubber or plastic gloves, apron, boots, and chemical-type safety goggles.

b. Avoid inhalation of vapors from liquids and dust from acid powder mixes.

c. Open acid containers, and use acid in well-ventilated areas. Avoid spilling and splashing.

d. Do not pour water into acid; slowly add acid to water, and constantly stir mixture with an acid-resistant implement.

e. Thoroughly rinse in tap water cloths, sponges, and brushes used to apply acid solutions. If allowed to dry without rinsing, they constitute a fire hazard.

f. If acid contacts skin, drench affected area in clean water for a minimum of 5 minutes.

g. Do not store acid near heat, caustics, water, or combustible materials.

1-8. LIQUID NITROGEN. Liquid nitrogen is characterized by its extremely low temperature and high vapor pressure. The following precautions must be observed by personnel handling liquid nitrogen:

a. Use only approved containers and storage vessels.

b. Wear safety goggles or face shield and loose, well ventilated gloves or mittens.

c. Avoid splashing on exposed skin to prevent painful injury (burns).

d. Use in a well ventilated area to prevent oxygen depletion.

e. Avoid direct contact with the liquid or surfaces chilled by the liquid.

1-9. INCOMPATIBLE MATERIALS. Some materials, such as preservative compounds, lubricating oil, cleaning solvents, and grease, used for maintenance purposes are incompatible with the oxidizer, liquid oxygen. When introduced into an oxidizer system, liquid oxygen mixes with the incompatible materials that have not been removed by cleaning, flushing, and purging and becomes impact-sensitive and explosive. The detection of all incompatible materials in an engine or test equipment is difficult. Engine and equipment must be protected by the methods outlined in applicable maintenance procedures to avoid the extensive disassembly required for the detection and removal of incompatible materials.

1-10. SEALS AND GASKETS. Seals and gaskets must be compatible with, and serviceable in, the system in which they are used. Many fluids are extremely corrosive and volatile, and others decompose violently when exposed to certain substances. Personnel must take all safety precautions and avoid bringing materials into contact with each other unless they are known to be compatible. Some types of seal and gasket material, such as Teflon and KEL-F, are used with the propellant system because of their flexibility at low temperatures. These materials form a toxic fluorocarbon gas when burned or overheated. Adequate ventilation must be provided where any temperature above 400° F may be reached. Seals and gaskets must be replaced with new seals and gaskets during assembly and installation of parts and components.

1-11. ENVIRONMENTAL REQUIREMENTS.

1-12. Maintenance tasks requiring the removal, installation, and/or repair of components or parts must be performed in a controlled area. Requirements for a controlled area (component repair area, engine repair area, engines in test stand, or engines installed in stages) are outlined in J-2 Rocket Engine Maintenance Plan R-5101.

1-12A. MATERIALS.

1-12B. Figure 1-A1 lists and summarizes the use of materials required to perform tasks specified in this manual (Volumes I and II).

1-13. CONTAMINATION AND DAMAGE PREVENTION REQUIREMENTS.

1-14. All maintenance and repair procedures must be performed in such a manner as to prevent contamination of engine components and systems. These requirements are satisfied when the following conditions are met:

a. Clothing worn by personnel is free of loose particles and fibers, and pockets emptied of foreign objects that could contribute to contamination.

b. Only the required parts, tools, and test equipment are allowed in the maintenance or repair area; an inventory of tools and parts is taken at the beginning and end of a procedure.

c. All test equipment, tools, and materials must meet the cleanness requirements for use in propellant and pneumatic systems.

d. Tools are properly tethered to the carrying individual or carried in a suitable tethered bag when work is being performed on upper stages of the vehicle.

e. Water shields and windbreaks are provided if an engine or facility system is to be opened in an outdoor location during rain or high winds.

f. Areas are checked above, around, and below the system being opened for operations that may occur to allow contamination of the system. Proper measures are taken to prevent contamination of engine systems when the stage hydraulic system is open.

g. Aluminum foil or any other item is never used in lieu of protective closures on engine openings or on removed components or assemblies.

h. Only pressure-sensitive tape RB0195-002 (Rocketdyne), or equivalent, is used in direct contact with engine assembly. Tape is not used on threads, mating and sealing surfaces, or direct fluid surfaces. Tape alone is not used as a protective closure on engine openings or on removed components or assemblies.

Identification	Name	Use
A-4000 (Dow Corning Corp)	Adhesive and catalyst	Two-part silicone adhesive.
A-4014 (Dow Corning Corp)	Primer	Primer for A-4000 adhesive.
Aclar No. 33C (Allied Chemical Corp)	Film	Protecting engine components, ducts and flanges, and open lines from contamination or damage.
Acrilonitrile-Butadiene-Styrene (Uniroyal, Inc)	ABS sheet	Repairing thrust chamber exit closures.
Adiprene L-100 (Du Pont)	Urethane rubber	Repairing start tank cover.
Alodine 1200 (Amchem Products)	Alodine powder	Refinishing anodic coated surfaces.
Aroclor 1248 (Monsanto Co)	Lubricant	Lubricating internal parts of OTBV and MFV.
ARP No. 2 (Allied Research Products)	Detergent	Cleaning anodic coated surfaces for refinishing.
Bear-Tex No. 85-1 (Norton Co)	Silicon carbon pad	Removing minor rust from exterior surfaces.
Boltaron 6100 (General Tire and Rubber Co)	Rigid ABS sheet	Repairing thrust chamber exit closure.
Boltaron 8800 (General Tire and Rubber Co)	Flexible ABS sheet	Repairing thrust chamber exit closure.
Bureau of Mines, Grade A	Helium	Pressurizing, purging, and leak-testing.
CAB-O-SIL (Cabot Corp)	Filler	Start tank cover minor repair.
Cellosize HEC QP-15000 (Union Carbide Corp)	Hydroxethyl cellulose	Cleaning external surfaces of engine and components.
D-4327 coating (Dyna-Therm Corp)(a)	Insulating coating	Repairing turbine crossover duct coating.
DC340 (Dow Corning Corp)	Heat sink compound	Installing thrust chamber jacket temperature transducer.
Duxseal (Johns-Manville Products)	Waterproof compound	Installing thrust chamber jacket temperature transducer.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 1 of 10)

Identification	Name	Use
Eccobond solder No. 56C (Emerson and Cummings)[a]	Solder	Heat transfer agent under thrust chamber jacket temperature transducer.
EC1357 (Minnesota Mining and Mfg)[a]	Adhesive	Repairing thrust chamber exit closure.
ERL2795 (Union Carbide Corp)	Epoxy resin	Repairing start tank cover.
ERL2807 (Union Carbide Corp)[a]	Epoxy hardener	Repairing start tank cover.
Fiberthin No. C-1125 (Uniroyal, Inc)	Plastic sheet	Repairing thrust chamber exit closure.
FS1281 (Dow Corning Corp)	Grease	Lubricating electrical connector threads and gasket, and inside of thermal protecting boot during installation.
Gloves (Dickson Safety Products Co)	Neoprene gloves	Protecting hands while removing and installing insulation.
Gloves (Plastic Smith)	Polyethylene gloves	Protecting hands while cleaning closures, parts, test plates, and tools.
Handy Flux (Handy and Harman)	White handy flux	Repairing thrust chamber and brazing lines.
Handy Flux, Type B1 (Handy and Harman)	Black handy flux	Repairing thrust chamber and brazing lines.
Iridite 14-2 (Allied Research Products)	Iridite powder	Refinishing anodic coated surfaces.
Kulgrid (Sylvania Electric Products, Inc)	Wrapping wire	Repairing armored harness braid.
Kulgrid 28 (Sylvania Electric Products, Inc)	Wrapping wire	Repairing armored harness braid.
L-P-378, Type II (Federal Specification)	Plastic sheet and strip	Protecting open lines, clean components, or component sealing surfaces from contamination.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 2 of 10)

Identification	Name	Use
LB0190-002 (NR, Los Angeles Division)	Pressure-sensitive tape	Masking repair area of harness, and retaining and sealing potting compound.
Locktite, Grade C (Locktite Corp)	Sealing compound	Installing transducer electrical connectors in auxiliary and primary instrumentation packages.
Malachite Green Dye (Allied Chemical Corp)	Dye	Major repair of start tank cover.
Micro-Fiber felt, Type 475 or Type E (Johns-Manville Products)	Felt insulation	Installing or repairing micro-fiber felt insulation.
MIL-A-18455	Argon gas	Inert-gas welding.
MIL-A-6091	Denatured alcohol	Cleaning closures, tools, and repair areas.
MIL-B-131	Vaporproof barrier material.	Masking areas during insulation repair.
MIL-C-11796B, Class 3	Corrosion preventive compound	Removing primary flight instrumentation package.
MIL-C-5410	Cleaning compound	Applying chemical film touchup to anodic-coated parts.
MIL-C-5501	Protective caps and plugs.	Protecting open lines and ports from contamination.
MIL-C-81302	Cleaning compound	Cleaning, removing compounds, adhesives, resin, and tenacious residues.
MIL-D-3464	Desiccant	Installing protective covers.
MIL-F-14256	Soldering flux	Repairing flight instrumentation package wire harnesses.
MIL-L-25567	Leak-test compound	Leak-testing seams, welds, and threaded connections.
MIL-P-27401	Nitrogen	Purging, drying, and cryogenic testing.
MIL-P-8585[a]	Zinc chromate primer	Corrosion protection for fuel turbopump, and touchup repair for thrust chamber painted surfaces.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 3 of 10)

Identification	Name	Use
MIL-R-5031	CRES 347 filler rod or wire	Repairing thrust chamber pinholes by TIG welding and heliarc repair of cracks in drain bosses.
MIL-T-19588	Toluene	Thinning eccobond solder compound.
MIL-T-27602	Trichloroethylene	Cleaning interior and exterior surfaces, and removing compounds and resin during repair.
MIL-T-81533	Trichloroethane	Cleaning interior and exterior surfaces, and removing compounds and resin during repair.
Moca curing agent (Du Pont)	Catalyst	Repairing start tank cover.
Molykote G (Dow Corning Corp)	Paste lubricant	Lubricating threads.
Molykote L (Dow Corning Corp)	Paste lubricant	Assembling fuel turbopump.
Molykote Z (Dow Corning Corp)	Powder lubricant	Installing thrust chamber injector, vent port check valves, relief valve, and LOX turbopump inducer bolt.
MSFC-PROC-404 (NASA Specification)	Air	Drying clean parts.
MSFC-SPEC-237 (NASA Specification)	Cleaning solvent	Cleaning engine and component external surfaces.
MS20995N (Military Standard)	Inconel lockwire	Safetying electrical connectors.
Narmco 7139 (Narmco Industries)	Catalyst	Repairing start tank cover.
Narmco 7343 (Narmco Industries)	Elastomer	Repairing start tank cover.
No. 107 (LA Standard Rubber)	Rubber band	Installing and repairing insulation.
No. 181 Volan (Hess Goldsmith and Co)	Fiber glass cloth	Repairing start tank cover.

Figure 1-A1. Materials Specified in This Manual (Sheet 4 of 10)

Identification	Name	Use
No. 4420 (Connecticut Hard Rubber Co)	Silicone rubber electrical tape	Repairing spark igniter cable ablative protective covering.
No. 7815 (Victor Gloves, Inc)	Nylon cloth	Cleaning and wiping parts.
No. 7862 (Victor Gloves, Inc)	Nylon gloves	Disassembling, assembling and cleaning components.
No. 9 (Emerson and Cummings)	Catalyst	Preparing heat transfer agent for thrust chamber jacket temperature transducer mounting pad.
No. 97487 (Sears, Roebuck and Co)	Hair-felt weatherstrip	Installing and repairing insulation.
Nu-Wipe (Lacquerwax Co)	Paper tissue toweling	Handwiping engine, components, closures, test plates, and tools.
Nuocure 28 (Tenneco Chemicals)(a)	Catalyst	Mixing and applying fast curing adhesive.
O-A-51 (Federal Specification)	Acetone	Cleaning surfaces to be insulated or potted, and removing marking dye or ink.
O-E-760 (Federal Specification)	Ethyl alcohol	Cleaning tools.
O-N-350 (Federal Specification)	Nitric acid	Passivation, cleaning for anodic touchup, and minor rust removal.
O-O-670 (Federal Specification)	Phosphoric Acid (85%)	Removing tarnish from electrical connector pins.
O-T-620 (Federal Specification)	Trichloroethane	Cleaning surfaces to be welded.
Oakite No. 61B (Oakite Products, Inc)	Cleaner	Cleaning protective closures, test plates, and handtools.
P-C-451 (Federal Specification)	Abrasive cloth	Removing protective finish from bonding surfaces and cleaning surfaces for welding.
P-D-680 (Federal Specification)	Drycleaning solvent	Removing adhesive deposits, cleaning prior to repainting, and cleaning closures, test plates, and tools by handwiping.
P-S-311, Type I or Type II (Federal Specification)	Scouring powder	Cleaning external surfaces of engine and components.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 5 of 10)

Identification	Name	Use
Permacel P421 (Johnson and Johnson, Inc)	Tape	Installing seals with installation tool 557217.
Plastic bag (Polyfab Co)	Bag 24 in. long x 28 in. wide x 6 mils thick	Installing insulation on ECA and support rod and repairing insulation on ECA and OTBV.
PPP-T-60 (Federal Specification)	Waterproof tape	Securing parts in position during installation.
PR-1531 (Products Research and Chemical, Semco)(a)	Primer	Priming for potting compound.
PR-1532 (Products Research and Chemical, Semco)(a)	Potting compound	Potting to seal fuel turbopump volute.
PR-1553 (Products Research and Chemical, Semco)(a)	Potting compound	Repairing black overmols.
Presstite 587.3 (Interchemical Corp)(a)	Tape	Installing and repairing insulation.
P2650 (Johnson and Johnson, Inc)	Silicone rubber tape	Installing insulation on fuel bleed line and as an abrasion preventative material between electrical cable and helium regulator hose.
QQ-S-571 (Federal Specification)	Lead-tin solder Sn60 or Sn63	Repairing armored harness braid.
RB0120-029 (Rocketdyne)	Slow-curing adhesive	Insulating components.
RB0120-030 (Rocketdyne)(a)	External coating	Insulating LOX turbopump volute and minor insulation repair.
RB0120-033 (Rocketdyne)(a)	Fast-curing adhesive	Insulating components.
RB0120-036 (Rocketdyne)(a)	Silicone primer	Priming surfaces for insulation.
RB0125-001 (Rocketdyne)(a)	Passive-temperature-control coating	Repairing painted surfaces.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 6 of 10)

Identification	Name	Use
RB0130-068 (Rocketdyne)[a]	Silicone-base foam and catalyst	Insulating LOX turbopump volute and minor insulation repair.
RB0140-002 (Rocketdyne)	Thread sealant tape	Applying thread sealant tape.
RB0140-005 (Rocketdyne)	Sealing and antiseize compound	Lubricating shafts, O-rings, and threads.
RB0140-009 (Rocketdyne)	Sealing and antiseize compound	Lubricating threads.
RB0140-012 (Rocketdyne)	Lubricant grease	Lubricating packings, O-rings, and threads.
RB0150-026 (Rocketdyne)	Tying tape	Installing insulation and heat shrinkable tubing.
RB0170-064 (Rocketdyne)	Gold-nickel brazing alloy	Making thrust chamber tube-to-tube repair.
RB0170-089 (Rocketdyne)	Gold-silver-copper-zinc brazing alloy	Brazing lines, and filling dents and scratches in thrust chamber tubes.
RB0195-002 (Rocketdyne)	Pressure-sensitive tape	Direct contact with engine assembly, retaining parts for welding, leak-testing welded joints, installing protective covers and closures, and retaining protective material during component removal and installation.
RB0210-003 (Rocketdyne)	Trichloroethylene	Cleaning internal parts.
Royalite 20 or 70 (Uniroyal, Inc)	ABS sheet	Repairing thrust chamber exit closure.
RTV-102 (General Electric)[a]	White sealant	Installing and repairing insulation.
RTV-103 (General Electric)[a]	Black sealant	Repairing insulation.
RTV-106 (General Electric)	Red sealant	Repairing insulation.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 7 of 10)

Identification	Name	Use
RTV-560 (General Electric)[(a)]	Adhesive	Repairing insulation.
RTV-9950 (General Electric)	Catalyst	Mixing and applying adhesives.
Rubber band (Dykema Rubber Band Co)	Special rubber band	Repairing thrust chamber insulation.
SA01020 (Moxness Products, Inc)	Silicone reinforcing tape	Installing insulation on fuel bleed line.
SF-250-C6-RTV-102 (Products Research and Chemical, Semco)[(a)]	Sealant	Repairing damaged start tank potting.
SF-650-RTV560/9950 (Products Research and Chemical, Semco)	Adhesive	Repairing insulation.
SF-667-RTV560/9950 (Products Research and Chemical, Semco)[(a)]	Adhesive	Repairing insulation.
SKD-NF (Magnaflux Corp)	Spot-check developer	Performing dye-penetrant inspection.
SKL-4 (Magnaflux Corp)	Dye-penetrant	Performing dye-penetrant inspection.
Strip Kleen No. 171 (Sinclair Paint Co)	Paint remover	Removing damaged paint finishes from thrust chamber.
ST0125RB0003 (Rocketdyne)	Blue-tinted lacquer	Protective finish on bonded areas.
ST0130RB0078, Type I (Rocketdyne)	Silicone rubber tape	Repairing green overmolds.
ST0210GB0002 (NR, Los Angeles Division)	Trichloroethane	Cleaning external surfaces of engine.
Thermolite 12 (M&T Chemicals, Inc)[(a)]	Slow-curing catalyst	Mixing and applying adhesives.
Thiourea (J.T. Baker Chemical Co)	Thiourea	Removing tarnish from electrical connector pins.
TT-I-735 (Federal Specification)	Isopropyl alcohol	Cleaning repair areas, electrical connectors, and protective closures. Removing marking dye or ink.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 8 of 10)

Identification	Name	Use
TT-L-32 (Federal Specification)	Cellulose lacquer	Refinishing and restenciling exit closure.
TT-M-261 (Federal Specification)	Methyl-ethyl-ketone	Cleaning surfaces to be insulated, cleaning repair areas on armored harnesses, removing protective coating from bonding areas, removing marking dye or ink, repairing start tank cover, and as bonding agent for thrust chamber exit closure and for humidity indicator threads.
TT-M-268 (Federal Specification)	Methyl-isobutyl-ketone	Thinning Dyna Therm coating D-4327.
TT-N-95 (Federal Specification)	Naphtha	Cleaning before insulating or repainting.
TT-T-266 (Federal Specification)	Lacquer thinner	Refinishing and restenciling exit closures.
TT-T-548 (Federal Specification)	Toluene	Removing and installing insulation, cleaning insulation repair area, and removing adhesive.
TT-X-916 (Federal Specification)	Xylene	Thinning passive-temperature-control coating.
Turco 4142 (Turco Products)	Cleaner	Cleaning external surfaces.
Turco 4215 (Turco Products)	Cleaning compound	Cleaning start tank cover.
Turco 4518 (Turco Products)	Cleaner	Cleaning external surfaces.
Tygon tubing (U. S. Stoneware, Inc)	Plastic tubing	Protecting inside of start tank during vacuum cleaning.
Uralane 5712 A and B (Furane Plastics, Inc)[(a)]	Elastomer	Repairing start tank cover.
UU-T-106 (Federal Specification)	Masking tape	Masking during removal, installation, or repair of insulation.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 9 of 10)

Identification	Name	Use
Zinc chromate (W. P. Fuller Paint Co)	Sealer	Repairing OTBV insulation.
1200 RTV (Dow Corning Corp)	Primer	Repairing heat shrinkable overmolds and tubing.
15-SS (Gordon Brush Mfg Co)	Wire brush	Repairing turbine cross-over duct coating.
3M-425-1 and -2 (Minnesota Mining and Mfg)	Aluminum tape	Installing and repairing insulation.
403-108 (Du Pont)	Fiberglass sheet	Used as a guide when installing silicone rubber tape.
46-SS (Gordon Brush Mfg Co)	Wire brush	Repairing turbine cross-over duct coating.
549 (Minnesota Mining and Mfg)	Plastic film	Used for sealing when leak-testing components.
55 or 55M (Dow Corning Corp)	Pneumatic grease	Lubricating STDV bolt threads.
602 (Moxness Products, Inc)	Tape	Abrasion protection for electrical cable and helium regulator hose.
8105-782-7460 (Federal Stock No.)	Polyethylene tubing	Protecting open lines, clean components, or component sealing surfaces from contamination. Protecting electrical wiring and nonmetal parts during cleaning operations.
8135-LCO-6811 (Federal Stock No.)	Polyethylene bag	Packaging pressure caps, plugs, seals, and small parts retained for reinstallation.
92-018 (Dow Corning Corp)[(a)]	Aerospace sealant	Repairing insulation and heat shrinkable tubing and overmolds.

(a) Compound has limited shelf life. Refer to paragraph 1-111 for usability test.

Figure 1-A1. Materials Specified in This Manual (Sheet 10 of 10)

i. Protective closures are not used as storage trays for removed hardware or hardware to be installed.

j. Component and engine sealing flanges are protected with polyethylene bags or sheets (0.004 inch minimum thickness) secured with pressure-sensitive tape RB0195-002 (Rocketdyne), or equivalent, during removal, positioning, and fitting of components. Tape, polyethylene film, and/or bags are removed just before physically making the connection.

k. Clean, required permanent closures and covers (plugs, caps, and plates) are installed on engine or component flanges, ports, or openings when opened or exposed. (Refer to paragraph 1-15 for closures and covers.)

l. Components and parts being removed from an engine system must be handled as follows to prevent contamination:

(1) Surveillance is required to verify that neither the component nor the engine is contaminated during component removal.

(2) Surfaces adjacent to joints being disconnected are clean prior to loosening joints.

(3) All cavities in component and parts are checked for lockwire clippings or any foreign material before component removal.

(4) Clean nylon or polyethylene gloves are worn when handling parts or components where hand contact is made with sealing surfaces or surfaces that contact operating fluid (liquid or gas).

(5) Necessary clean, protective closures and covers (paragraph 1-15) are available for installation to protect parts.

(6) Exposure time of openings must be kept to a minimum.

(7) Openings must be protected as they are exposed during component removal. (Refer to steps j and k.) Prior to installation of protective closures, exposed areas are visually inspected (paragraph 1-104).

(8) Pressure caps, plugs, seals, and miscellaneous small parts being retained for reinstallation are visually inspected (paragraph 1-104) and then packaged in clean plastic sheet and strip (Federal Specification L-P-378, Type II). The package is secured by heat-sealing or with pressure-sensitive tape RB0195-002 (Rocketdyne).

NOTE

Clean polyethylene bags (Federal Stock No. 8105-LC0-6811) or clean polyethylene tubing (Federal Stock No. 8135-782-7460), heat-sealed at one end, may be used. All polyethylene material used must be 0.004 inch minimum thickness.

(9) Protective closures are secured with the required number of attaching parts. If fewer than the required number of attaching parts are used, the protective closure will not provide adequate protection.

(10) Component cleanness is verified and each protective closure certified so that protective closure removal would void cleanness certification.

m. Ground support equipment and special tools used on the engine and components must be complete, undamaged, and meet engine system and component cleanness requirements. Ground support equipment and special tool description, operation, and maintenance information is in R-3825-5.

mA. All materials used on the engine must be compatible with the applicable engine system and conform to those listed in figure 1-A1.

n. Components and parts being installed in an engine system must be handled as follows to prevent contamination:

(1) Surveillance is required to verify that neither the parts, components, nor engines are contaminated during component installation.

(2) Closures are properly installed and not damaged in a manner that allows component to be contaminated. Packages are sealed and undamaged.

(3) Each closure installation is certified clean. If component is packaged, certification of cleanness may be installed on exterior of package.

(4) Surfaces adjacent to joints being connected are clean.

(5) Exposure time of openings must be kept to a minimum.

(6) Engine and component are visually inspected (paragraph 1-104) when closures are removed.

(7) Closures are retained on component and engine openings until necessary to complete installation or protected as required in step j.

(8) Engine system in which component is to be installed is inspected to make sure closures are properly installed and cleanness certified.

(9) Prior to installation, all gaskets, O-rings, packings, and seals are verified free of contamination and not damaged. New gaskets, O-rings, packings, and seals must be used in installation of parts and components.

(10) Proper lubricant is used on fittings, gaskets, O-rings, packings, and seals when required by the applicable procedures and only in the amount required.

o. Components or assemblies requiring rework or reinspection are transported to a controlled area before removing protective closures.

p. Either proper preventative measures are taken to eliminate contamination during rework that generates chips, dust, or contaminants, or reworked part is cleaned after rework.

CAUTION

The reliability and durability of the engine can be adversely affected by applying unnecessary loads on engine lines or components.

q. Unnecessary loads and/or rough treatment, such as stepping on or supporting weight, must not be applied to engine lines or components.

r. Additional brackets, lines, clamps, or other hardware must not be attached to the engine without Rocketdyne concurrence.

1-15. ENGINE PROTECTIVE CLOSURES AND COVERS. Approved engine closures and covers provide a seal against moisture and contaminants and physically protect ports, threads, sealing surfaces, and electrical connectors. (See figure 1-1.) All parts of the engine that require protective closures and covers must be protected at all times unless protective closures and covers are removed for the performance of an authorized activity. Engine and component protective closure part numbers are specified in R-3825-4. For closure removal and installation procedures, refer to section III; and for closure and cover usage and desiccant installation, refer to R-3825-1B. General protective closure requirements are as follows:

a. Protective closures must be clean and free of damage. If required, clean protective closure as outlined in paragraph 1-96.

aA. Closures having sponge rubber must not be used, since contamination of component or system can result.

b. Protective closures to be installed on engine system joints must be cleaned immediately prior to installation or be individually packaged and certified clean. (Refer to paragraph 1-101.)

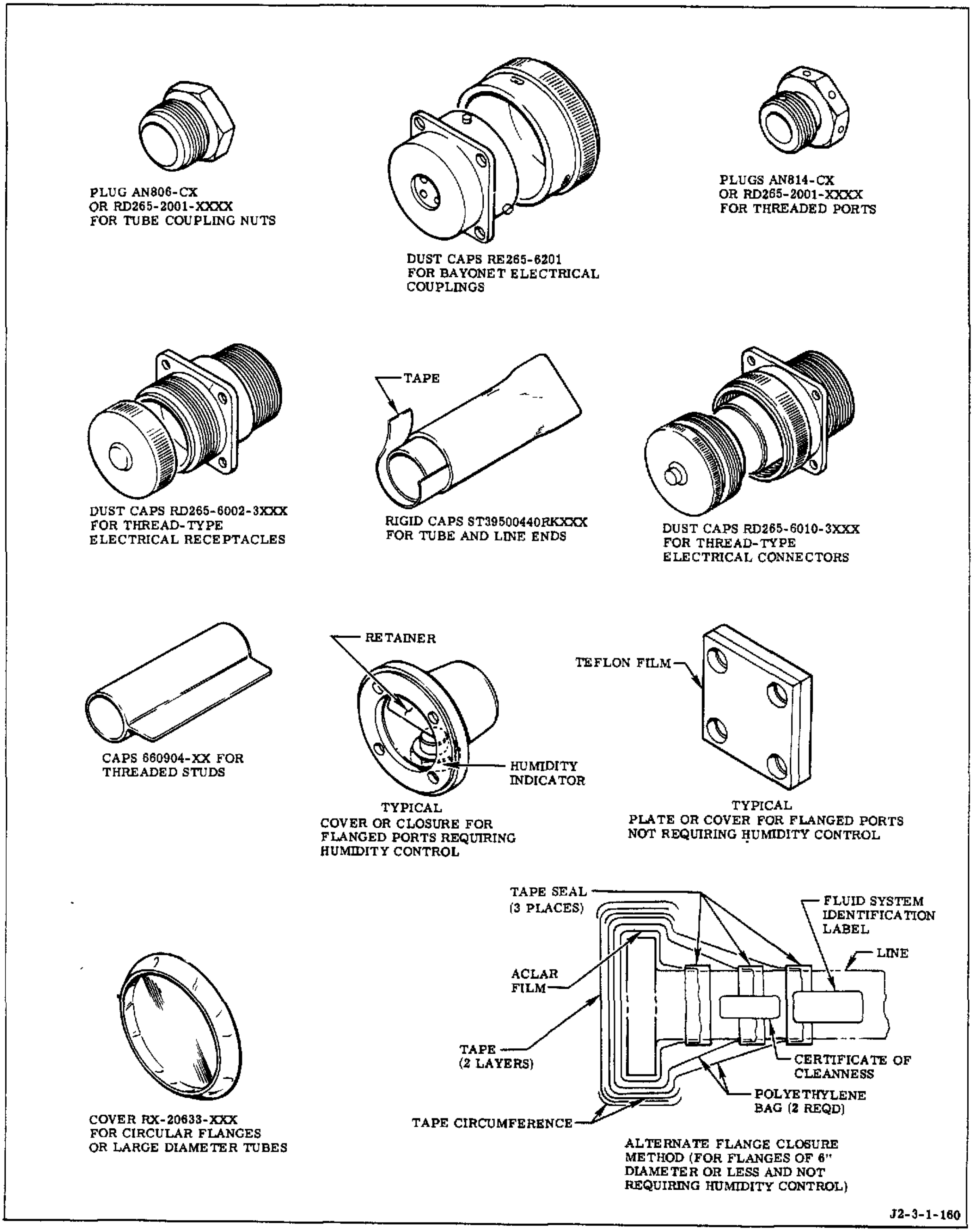


Figure 1-1. Closures and Covers (Typical)

c. Clean closures to be reinstalled on the same engine system component must be temporarily packaged in new, visually clean commercial polyethylene plastic bags. Close bags by taping, heatsealing, or tying.

d. Thrust chamber exit closure repair procedures are contained in R-3825-3, Volume II.

e. Humidity indicators that are missing or broken or that have indicator coloration overrunning the established circular border or all coloration lost, must be replaced as follows:

(1) Remove indicator by breaking free retaining nut that secures indicator to closure.

(2) Install rubber packing over threads of indicator and against indicator head; then install fiber bushing over outside of packing making sure packing lays flat and is not twisted.

(3) Place indicator in position with threads through hole in rim segment.

(4) Install plastic indicator retaining nut, and torque nut as tightly as possible by hand to compress rubber packing.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

(5) Place 2 drops of methyl-ethyl-ketone (Federal Specification TT-M-261), or equivalent, on threads of indicator and nut.

f. If closures and covers specified are not available, flange areas may be protected as shown in figure 1-1 and as follows:

CAUTION

When securing Aclar film or bags to the line with tape, a minimum of 25 percent of the tape width must contact the body of the line to prevent entry of contaminants.

NOTE

The tape used in this procedure is pressure-sensitive tape RB0195-002 (Rocketdyne).

(1) Cover open ends of line with Aclar No. 33C film (0.002-inch minimum thickness) (Allied Chemical Corp). Film must be wrapped over the periphery of the flange and secured to the body of the line with tape.

(2) Install a bag (0.004-inch minimum thickness) made from clean plastic sheet and strip (Federal Specification L-P-378, Type II) over Aclar film to completely cover and extend beyond film. Expel air from bag, and secure bag to body of line with tape.

NOTE

Clean polyethylene bags (Federal Stock No. 8105-LC0-6811) or clean polyethylene tubing (Federal Stock No. 8135-782-7460), heat-sealed at one end, may be used. All polyethylene material used must be 0.004-inch minimum thickness.

(3) Attach a certificate of cleanness to taped area, if required.

(4) Install a second bag (0.004-inch minimum thickness) made from clean plastic sheet and strip (Federal Specification L-P-378, Type II) over first bag. Expel air from bag, and secure bag to body of line with tape.

NOTE

Clean polyethylene bags (Federal Stock No. 8105-LC0-6811) or clean polyethylene tubing (Federal Stock No. 8135-782-7460), heat-sealed at one end, may be used. All polyethylene material used must be 0.004-inch minimum thickness.

(5) Gather and tape bag over periphery of flange to prevent flange from cutting through bag.

(6) Apply 2 layers of tape over outer bag. Tape must cover surface of flange and extend over periphery of flange. Secure ends of tape by applying a layer of tape around periphery of flange.

(7) Attach a fluid system identification label to line, if required.

1-16. <u>INSPECTING PARTS FOR DAMAGE.</u>

1-17. Visual inspection is normally a satisfactory method for determination of damage to parts. However, if damage is suspected but not apparent, the dye-penetrant inspection method may be used.

1-18. VISUAL INSPECTION FOR DAMAGE. The parts of the component must be inspected for defects as follows:

a. Threaded inserts for loose inserts, damaged threads, and correct installation depth.

b. Tapped threads for damaged threads. Threads in parent metal must be inspected if the insert is removed.

c. Electrical connectors for fungus, loose and damaged pins, and stripped, burred, and crossed threads.

d. Dynamic and static sealing surfaces for nicks, burs, and scratches that could impair sealing function.

e. Anodic coated surfaces for worn or damaged coating.

1-19. DYE-PENETRANT INSPECTION METHOD. Dye-penetrant inspection (liquid oxygen safe) is used for parts treated with film or anodic coatings and parts used for direct or indirect liquid oxygen service. This method may be used to detect surface defects or indications of possible defects in parts made of nonabsorbent, nonporous material. Dye-penetrant indications are not necessarily cause for rejection. It is the responsibility of the dye-penetrant inspector certified by MIL-STD-410 to determine if an indication actually represents a defect.

a. Clean parts to be dye-penetrant inspected using appropriate cleaning procedure for part and type of service for which part is to be used.

b. Brush or spray a light, even coat of SKL-4 dye-penetrant (Magnaflux Corp) on areas to be inspected.

c. Allow penetrant to remain on part for a minimum of 5 minutes at normal room temperature (60° to 90° F). If parts are cold (30° to 60° F), increase time to a minimum of 30 minutes.

d. Remove excess penetrant with a clean, dry cloth followed by a water-dampened cloth.

e. Dry parts thoroughly by air-drying or a circulating air dryer. Do not apply direct heat to part.

f. Thoroughly mix SKD-NF spot-check developer (Magnaflux Corp) and apply a thin, even coat on area of part to be inspected.

g. Allow developer to remain on part for a minimum of 5 minutes; then inspect area for defects.

h. Clean part after inspection using applicable cleaning procedure for part and type of service in which part is being used.

1-20. <u>REPAIRING ANODIC-COATED AND DAMAGED SEALING SURFACES.</u>

1-21. Damage consisting of scratches or abrasions on anodized surfaces may be touched up by the brush-on method using chemical film materials and treatments that meet the requirements of MIL-C-5541. When damage to the anodized surface is extensive and requires that the part be completely reanodized, strip anodic coating and reanodize in accordance with MIL-A-8625.

1-22. APPLYING CHEMICAL FILM TOUCHUP TO ANODIC-COATED PARTS.

1-23. Damage on chromic acid anodic-coated parts not exceeding one percent of the total anodized surface may be refinished by a touchup film coating for aluminum parts. If damage exceeds one percent of total anodized surface, part must be stripped and reanodized. Small scratches or abrasions on anodized surfaces may be touched up by the brush-on method if the damaged area is no more than one percent of the total anodized area or 4 sq in., whichever is smaller. A maximum of four separate touchup areas is permitted on a single part, but the combined area must not exceed the aforementioned limits.

a. Obtain the following:

(1) Iridite 14-2 solution (Allied Research Products)

(2) APR No. 2 detergent (Allied Research Products)

(3) Alodine 1200 powder (Amchem Products)

(4) Cleaning compound (MIL-C-5410, Type II)

(5) Nitric acid (Federal Specification O-N-350)

(6) Trichloroethylene (MIL-T-27602) or trichlorethane (MIL-T-81533)

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of the vapors or prolonged contact with the liquid can cause serious injury or death.

b. Clean part with trichloroethylene and dry with soft, clean cloth.

c. Deoxidize part by applying a mixture of one part by volume of cleaning compound (MIL-C-5410, Type II) and one part distilled or deionized water at 65° to 90° F. Use a soft-bristle brush or clean cloth to apply mixture and keep surface wet for 5-10 minutes.

d. Rinse part in clean tap water (room temperature) using a spray or wiping with a clean cloth frequently wrung out in clean water. Surface must form an unbroken water film (paragraph 1-105).

WARNING

The following procedure specifies Iridite and Alodine solutions, which are acids. Contact with the solutions can cause serious injury to personnel or damage to equipment.

e. Prepare an Iridite solution by mixing 6 ounces of Iridite 14-2 powder (Allied Research Products) and 0.01 ounce of ARP No. 2 detergent (Allied Research Products) in one gallon of water, or prepare an Alodine solution by mixing 4 ounces of Alodine 1200 powder (Amchem Products) with 0.5 ounce of nitric acid in one gallon of water.

f. Using a soft-bristle brush or clean cloth, coat part with Iridite solution for 3-5 minutes or with Alodine solution for 1-3 minutes. Coat only a small area at one time. If no color develops, repeat steps c, d, and f.

g. Rinse part by flushing with tap water. Avoid hand-rubbing, since wet film is easily removed.

CAUTION

Organic material upon which Iridite or Alodine solutions have dried become highly flammable.

h. Thoroughly rinse solution from brushes and cloths.

1-24. REPAIRING DAMAGED SEALING SURFACES.

1-25. Field repair is authorized for damaged sealing surfaces of any engine or component flange. In each specific instance, contact the Rocketdyne Field Engineering Representative, who will determine disposition of damage and provide all applicable repair instructions.

1-26. APPLYING LUBRICANTS, SEALANTS, AND COMPOUNDS.

1-27. Lubricants, sealants, and compounds that are contaminated, whose shelf life has expired, or whose container labels are missing or unidentifiable must not be used. Clean nylon or polyethylene gloves must be worn where hand contact is made with sealing surfaces or surfaces that contact operating fluids (liquid or gas). Parts that will be reinstalled must have the original lubricant, sealant, or compound removed from the part and mating surfaces before lubricating. Lubricants, sealants, and compounds must be applied only to the areas designated. All stored containers must be tightly capped, and excess lubricant, sealants, or compounds must not be returned to the original container. All lubricants, sealants, and compounds must be free of grit, dirt, metal chips, or other foreign matter. The methods outlined in the following paragraphs, which will be referenced in the applicable procedures, must be used to apply lubricants, sealants, and compounds. The following definitions apply to these methods:

(1) O-ring: A circular packing, gasket, or seal having a torus or doughnut shape. The O-ring cross section is usually round and has a small diameter relative to the inside and outside diameter of the O-ring.

(2) Seal: Any sealing device other than an O-ring.

(3) Static Condition: When an installed part encounters no movement except for vibrational or load forces.

(4) Dynamic Condition: When an installed part encounters planned movement.

NOTE

Only the lubrication methods used in this manual (volume) are listed.

Figure 1-2 deleted.

1-28. METHOD A - APPLYING LUBRICANT TO STRAIGHT THREADS (STATIC CONDITION).

a. Using a clean nylon cloth, remove any existing lubricant from threads.

aA. Apply lubricant in a streak, flush with outside peaks of male threads, and across all threads except leading edge of first thread.

NOTE

The number and width of streaks vary with the outside diameter of threads.

b. Where more than one application is required, apply lubricant in equally spaced streaks around circumference of threads as follows:

(1) Threads up to 1/2 inch in diameter, one application 1/8 to 1/4 inch wide.

(2) Threads 1/2 to 1 inch in diameter, one application 3/8 inch wide.

(3) Threads 1 to 1-3/4 inches in diameter, two applications 1/2 inch wide.

(4) Threads 1-3/4 to 2-1/2 inches in diameter, three applications 1/2 inch wide.

(5) Threads 2-1/2 to 3 inches in diameter, four applications 1/2 inch wide.

(6) Threads over 3 inches in diameter, five applications 1/2 inch wide.

c. Distribute lubricant streaks uniformly around the threads with a clean nylon brush. Remove excess lubricant. Make sure there is no lubricant on leading edge of first thread, in fitting openings, or on flared or chamfered sealing surfaces.

1-28A. METHOD I - APPLYING THREAD SEALANT TAPE.

a. Remove any existing thread sealant from flange surfaces.

b. Apply thread sealant tape RB0140-002 (Rocketdyne) around external threads in the direction for loosening. Stretch tape slightly to conform tape to threads. Do not apply tape to engaging thread at end of fastener.

c. Overlap starting turn of tape by approximately 1/2-inch and break tape. If diameter of threads is one inch or more, use 2 identical wrappings side by side.

1-29. METHOD J - APPLYING LUBRICANT TO O-RINGS (STATIC CONDITION).

a. Distribute lubricant over O-ring surface to form a thin, uniform film.

b. Remove excess lubricant.

1-30. METHOD V - APPLYING LUBRICATING POWDER. Parts that have been special-cleaned need not be recleaned as outlined in this procedure. Soiled parts must be cleaned and lubricated as follows:

a. Clean and dry parts as outlined in paragraph 1-86.

b. Using a clean nylon cloth, rub powdered lubricant on surface until a film of uniform luster appears on all surfaces to be lubricated.

NOTE

Pressure-sensitive tape RB0195-002 (Rocketdyne) may be used for masking, if required.

c. Remove loose or caked powder.

d. Rub part with a clean, nylon cloth. The finished film must still appear after rubbing.

1-31 through 1-34. (Deleted)

1-35. HANDLING PRESSURE-ACTUATED (NAFLEX) SEALS.

1-36. All seals must be handled with care; however, Naflex seals are to be handled with extreme caution. The touch of a fingernail on the sealing surface of a Teflon-coated Naflex seal can destroy its sealing capability. A new seal must be installed whenever a joint is opened. Metal-plated seals must be used in a hot gas system and Teflon-coated and metal-plated Naflex seals as follows:

CAUTION

Sliding a seal out of a partially opened cardboard package may damage its sealing surface.

a. Remove seal from completely opened package immediately before installation.

b. Handle seal by outside surface only.

c. Do not slide seal across any surface.

d. Before installing seal, visually inspect flange sealing surfaces that seal will contact when seal is installed, to make sure foreign particles, nicks, and scratches are not present. Normal machining marks are acceptable.

CAUTION

The use of the wrong type of seals can result in seal failure and can cause damage to equipment.

e. Visually inspect coating of seal to make sure that sealing surfaces are free of nicks, scratches, and imperfections that can impair sealing capability.

f. When positioning seal on a flange, hold seal-flange movement to a minimum.

g. When installing seals between bolted flanges, carefully place seal between flanges; then install 2 opposite bolts and tighten just enough to close joint.

h. Install remaining bolts, and tighten all bolts to required torque using cross-torquing method (paragraph 1-44).

i. When installing seals between instrumentation bosses and instrumentation port plugs or similar joints, carefully position seal against boss mating surface. Thread plug into boss, keeping seal concentric with plug. (A 6-point socket wrench or similar standard tool may be used, when clearance permits, to keep seal concentric with plug.) Make sure seal is seated in seal recess (figure 1-3). On seal joints without seal recess, seal must be concentric to plug wrench flats within 0.012 inch. Tighten plug to required torque. Independently safety-wire instrumentation port plug to boss and leak-test port plug to instrumentation port plug.

j. When removing or installing leak-test plug of an instrumentation port plug, hold instrumentation port plug in place to make sure that torque value does not change.

k. Exercise extreme care when removing seals from engine, since they can be reprocessed to a like-new condition.

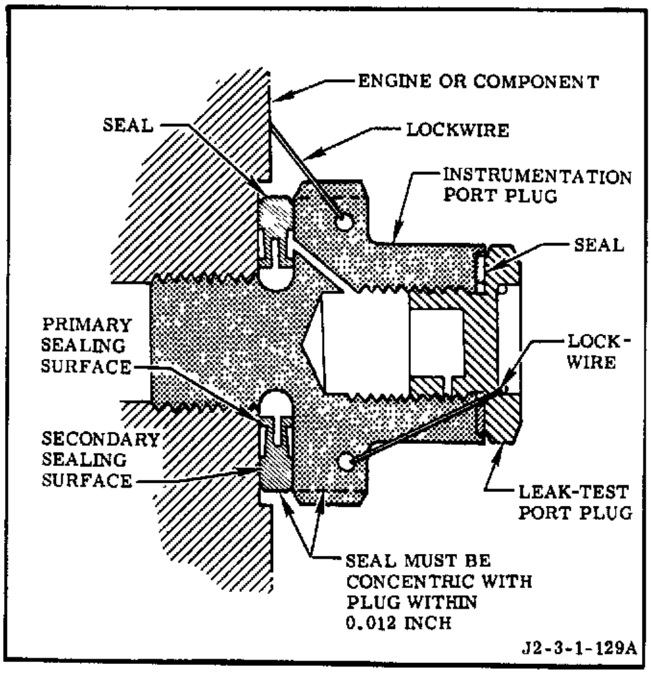


Figure 1-3. Instrumentation Boss Seal Installation

l. Package and return all used seals through normal supply channels for refurbishment.

m. Store seals in a safe place to prevent damage and contamination.

1-36A. INSTALLING K-SEALS.

1-36B. A new K-seal must be installed whenever a K-seal joint, except for seal monitoring port plugs, is loosened or opened. The RE261-3004-series K-seals are interchangeable with the 12100CR-series K-seals of equivalent dash number, size, and type. Inspect and install K-seals as follows:

a. Inspect and determine disposition of seal monitoring port K-seals only, as follows:

(1) If radial scratches are visually detectable (without magnification) on the sealing lips and flat-face surfaces, replace seal.

(2) If damage such as nicks or dents on any part of seal is obvious, replace seal.

(3) If flat-face coating or plating is uneven or is removed as a result of peeling or flaking, replace seal.

(4) Scratches with no apparent depth are acceptable.

(5) Circular contact marks resulting from normal installation wear are acceptable.

(6) Inspect seal for evidence of white deposits. Remove loose white deposits by wiping seal with a clean lint-free cloth. Replace seal if deposits cannot be removed by wiping.

b. Make sure the seal is being replaced by a seal with the correct part number.

c. Do not remove a seal from its package until ready for installation, and do not install a seal that has been improperly packaged.

d. Inspect and make sure seal and boss sealing surfaces are clean and free of dirt and chips and scratches, nicks, dents, and gouges, which could impair their sealing function. Normal machining marks on flanges are acceptable. Clean seal and boss as outlined in paragraph 1-86, if necessary, before installation. If need for cleaning results from white deposits on seal, remove white deposits by wiping seal with a clean lint-free cloth. Replace seal if deposits cannot be removed by wiping.

e. Lubricate fitting threads and K-seal (if specified in installation procedure) in accordance with the applicable method contained in this section. (K-seals are usually installed without lubrication.)

CAUTION

Failure to install a K-seal correctly will result in damage to the seal and leakage of the joint.

f. Install K-seal on fitting, as shown in figure 1-3A, with flatter surface of seal against shoulder of male threaded fitting.

g. Turn fitting into boss until conical surface of K-seal is in contact with chamfered surface of boss, using extreme care to aline seal to chamfered portion.

h. Tighten fitting to torque value specified in applicable installation procedure.

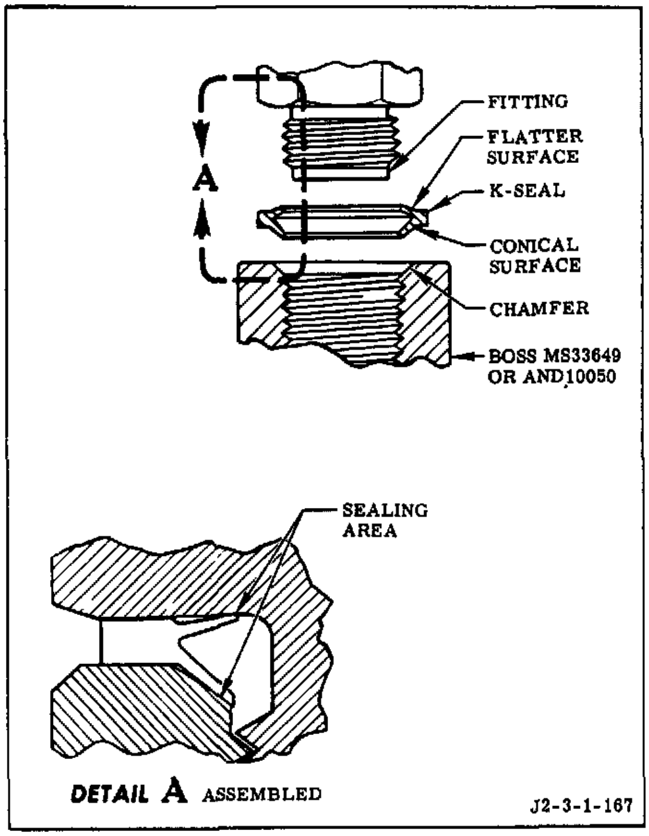


Figure 1-3A. K-Seal Installation (Typical)

1-37. INSTALLING THREADED FASTENERS.

1-38. During maintenance and repair, the installation of threaded fasteners is governed by the following general requirements:

a. Structural bolts or screws one dash number above that called out may be used to join pressurized or load-carrying components, providing the thickness of the joint-thinner flange at the bolthole location is 0.125 inch or greater.

b. For structural joints (load-carrying or pressurized), additional washers of the same callout may be added up to a total added thickness of 10 percent of the thickness of the thinner flange at the bolthole location.

c. Deviation of bolt-length dash numbers and the number of washers used in steps a and b is not permitted for bolts and screws used with screw-thread inserts.

d. For nonstructural applications, bolts or screws three dash numbers above or below those called out may be used if there is full thread engagement and if no interference occurs.

e. Single washers, except countersunk washers, are installed at the nut end; however, when more than one is specified, the washers must be evenly divided between the head and nut ends of the bolt.

f. There must be no threads in bearing in any part of a joint where the bolts or screws transmit a shear load, except one or two threads may be in bearing when the material next to the nut meets the minimum thickness requirement. Parts having relative movement at the fastener must not have threads in bearing.

g. Bolts used with self-locking nuts or inserts must not have cotter pin holes in the threaded shank.

h. Threaded parts must not be lubricated unless all of the following conditions prevail:

(1) Both parts are bare, corrosion-resistant steel.

(2) A lubricant for the service encountered is specified.

(3) A specific torque value is given.

i. (Deleted)

j. When a fastener is installed in a nut (except castellated nuts), at least one full thread must protrude through the top of the nut. Fasteners installed in inserts must penetrate the full length of the perfect threads of the insert.

1-39. INSTALLING COUNTERSUNK WASHERS.

1-40. Whenever countersunk washers are required, the countersunk side of the washer must be installed adjacent to the bolt fillet radii. Figure 1-4 shows a bolt and nut installation using countersunk washers.

1-41. TORQUING.

1-42. Torque is a twisting force used to apply tension to fasteners. Proper torque produces sufficient tension in tube fittings to create a tight seal while staying below the elastic limits of the part. To achieve proper tension by torque measurement, the parts must be clean, and when required, lubricated correctly, or false torque readings will result. The torque values called out in procedures in other sections of this manual are design requirements that result in maximum strength and sealing characteristics in the parts.

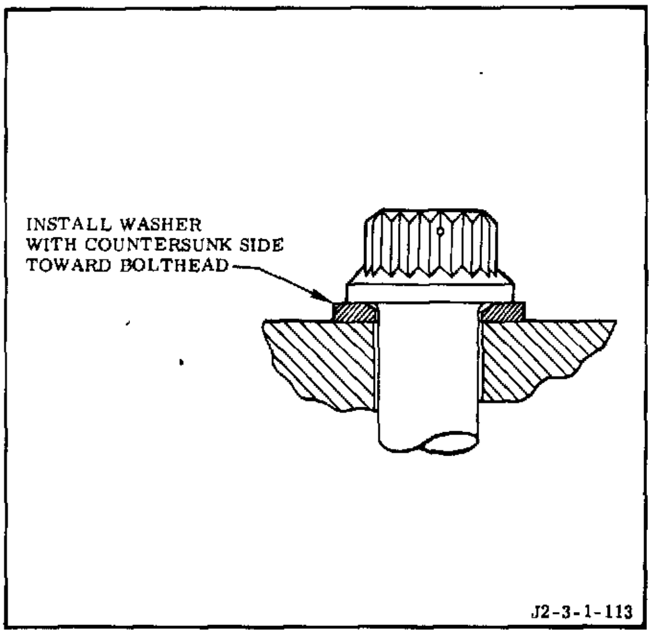


Figure 1-4. Installing Countersunk Washers

1-43. USING TORQUE WRENCH. Torque wrenches are precision tools and must not be subjected to abuse or misuse. The use of an extension (figure 1-5) on a torque wrench will result in greater torque application than indicated on the dial. To obtain correct torque readings, the following steps must be strictly adhered to:

a. All torque wrenches must meet the calibration requirements of Federal Specification GGG-W-00686, to compensate for wear. Do not use torque wrenches after the void date shown on each wrench, and never keep them in tool boxes or line supply cabinets.

b. Select the correct torque wrench so that wrench will be operated in its upper range (20-100 percent).

NOTE

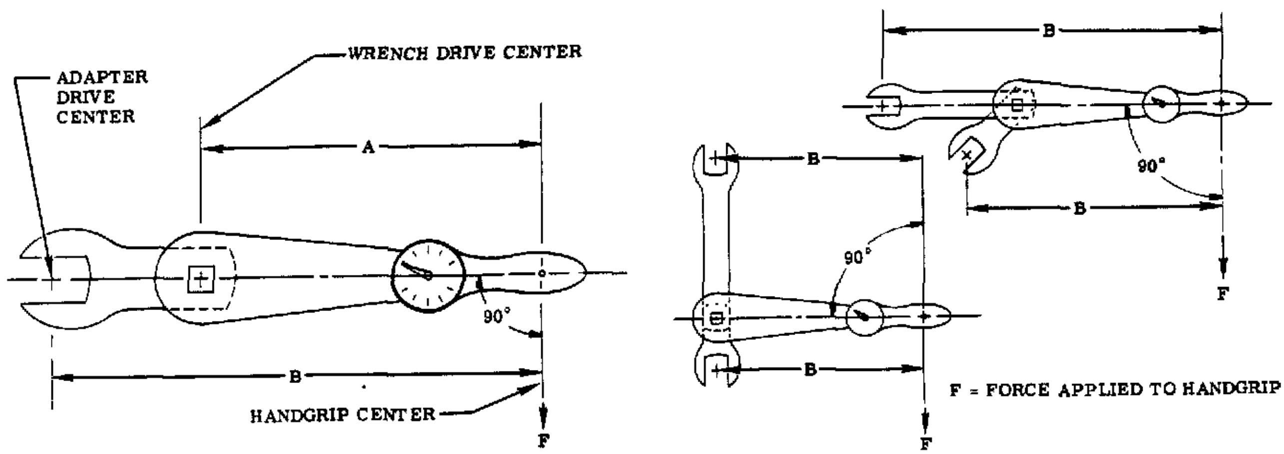
When a torque wrench is calibrated to Federal Specification GGG-W-00686, it is not necessary to compensate for calibration tolerances when applying torque values specified in the manual.

c. Take torque readings only while tightening the fastener. Do not overtighten and then loosen to the desired torque value.

d. Never jerk torque wrench. Apply force slowly and at 90 degrees to torque wrench handle for an accurate indication of torque being applied to fastener.

e. Do not attempt to use torque wrench to tighten fastener to a higher value than maximum value shown on torque wrench indicator.

f. Sockets must be installed fully on the nut or bolt. Maintain a slight inload on the tool to lessen the chances of damage to the fastener.



When using an extension adapter on a torque wrench, the actual torque value applied may be widely different from the indicated torque value and may be above or below the allowable tolerance unless the proper conversion is used. When the adapter is used at right angles to the torque wrench centerline, dimensions A and B are equal, the conversion factor is 1.00, and the indicated and applied torque values are the same. When the adapter is attached to the torque wrench to effectively lengthen or shorten the moment of applied force, the B dimension changes, and the indicated torque value must be converted to make sure that the proper torque value is applied as follows:

1. Measure length of torque wrench from handgrip center to wrench drive center. This is dimension A.
2. With adapter attached to torque wrench in position for use, measure length of torque wrench and adapter. This measurement (dimension B) is taken from handgrip center to adapter drive center.
3. Divide dimension A by dimension B to obtain conversion factor.
4. Multiply required torque value (applied) by conversion factor to obtain torque reading (indicated) that must be used with adapter on wrench. For example:

Dimension A on torque wrench is 12 inches. With adapter installed, dimension B is 17.365 inches. A – B = 12 ÷ 17.365 = 0.691. Assuming the torque wrench with the adapter installed as a straight extension is to be used to tighten a bolt for which the torque value is 570-630 in-lb, 0.691 x 570 = 393.87 and 0.691 x 630 = 435.33. The torque reading (indicated) to be used when this particular adapter is installed on the torque wrench is 394-435 in-lb. If this adapter were installed on the torque wrench in any other position, dimension B would be different and a different torque reading would apply.

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Figure 1-5. Computing Torque Values When Using an Extension or Adapter

1-44. FASTENER CROSS-TORQUE METHOD. Figure 1-6 is to be used as a guide for torquing bolted flanges or any bolted joint to apply an evenly distributed axial load to seals and gaskets. This procedure is to be used when a definite method of torquing is not specified. Cross-torque all bolts, following a numerical sequence similar to the applicable pattern in figure 1-6, and continue diagonally until all bolts are torqued to one-third of the total torque to be applied. Repeat this procedure, torquing the bolts in three increments until the total specified torque is obtained.

1-45. TORQUING FASTENERS IN PHENOLIC BLOCK AND LOOP-TYPE CLAMPS. When threaded fasteners are installed in phenolic block and loop-type clamps, all No. 10 fasteners must be torqued to 24-30 in-lb unless special torque values are specified in the procedures.

1-46. SAFETYWIRING.

1-47. Safetywiring is the securing together of two or more parts (bolts, screws, nuts, threaded fittings) with a wire that is installed in such a manner that the lockwire will be put in tension on at least one side of the part when the part tends to loosen.

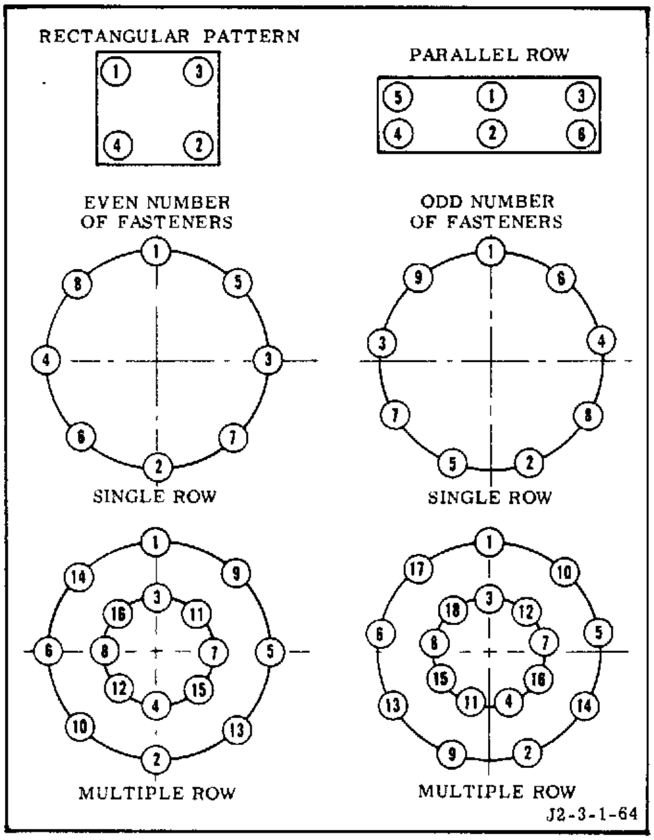


Figure 1-6. Fastener Cross-Torquing Method

1-48. SAFETYWIRING METHODS. The lockwire must be as short as possible and attached in the most direct manner. A pigtail of 1/4 to 1/2 inch (3-6 twists) must be made at the end of the wiring and bent back or under in a direction to increase tension and prevent it from becoming a snag. The lockwire must pass around the fastener head, except on MS-type internal-wrenching taper-head bolts, the wire must pass over the head and on 12-point external-wrenching head bolts, the wire or wires must pass through the head. The single-wire method may be used for small screws in a closely spaced, closed geometrical pattern, on parts in electrical systems, and in places that are difficult to reach. The double-twist method of safetywiring is normally used for most fasteners. When safetywiring widely spaced (maximum spacing is 6 inches) multiple groups by the double-twist method, three units is the maximum number in series. When safetywiring closely spaced multiple groups, the number of units that can be safetywired by a 24-inch length of wire is the maximum number in series. Any lockwire application that complies with MS33540 and meets the requirements of paragraph 1-47 and this paragraph, is acceptable. Typical safetywiring methods are shown in figure 1-7. Caution must be exercised during the twisting operation to keep the wire tight without overstressing. Abrasions caused by commercially available wire-twisting pliers are acceptable, but nicks, kinks, and other multilations caused by improper tooling and wiring techniques are not acceptable. In all cases wiring must be done through the holes provided. In the event that no wire hole is provided, wiring must be to a convenient adjacent part in a manner that will not interfere with the function of the part. Inconel lockwire MS20995N is used for safetywiring when specified in detailed installation and assembly procedures and the following items are drilled for lockwire:

(1) Bolts and screws (drilled heads and not secured with nuts)

(2) Nuts

(3) Electrical connectors

(4) Tubing coupling nuts

1-49. <u>REMOVING AND INSTALLING THREADED INSERTS.</u>

1-50. These procedures consist of removing and installing threaded inserts and studs. The Keenserts inserts and studs, Heli-Coil inserts, and Rosan inserts may be removed and replaced if damaged. The same size replacement insert or stud is installed in the undamaged, original tapped hole. Refer to R-3825-4 for correct part number, next assembly number, and location.

1-51. REMOVING KEENSERTS INSERTS. To remove a Keensert insert, drill to diameter and depth indicated in the Removal Data column of figure 1-8. Deflect exposed portion of kees inwardly and break off. Drive in E-Z Out-type extraction tool and back out insert. (See figure 1-9.)

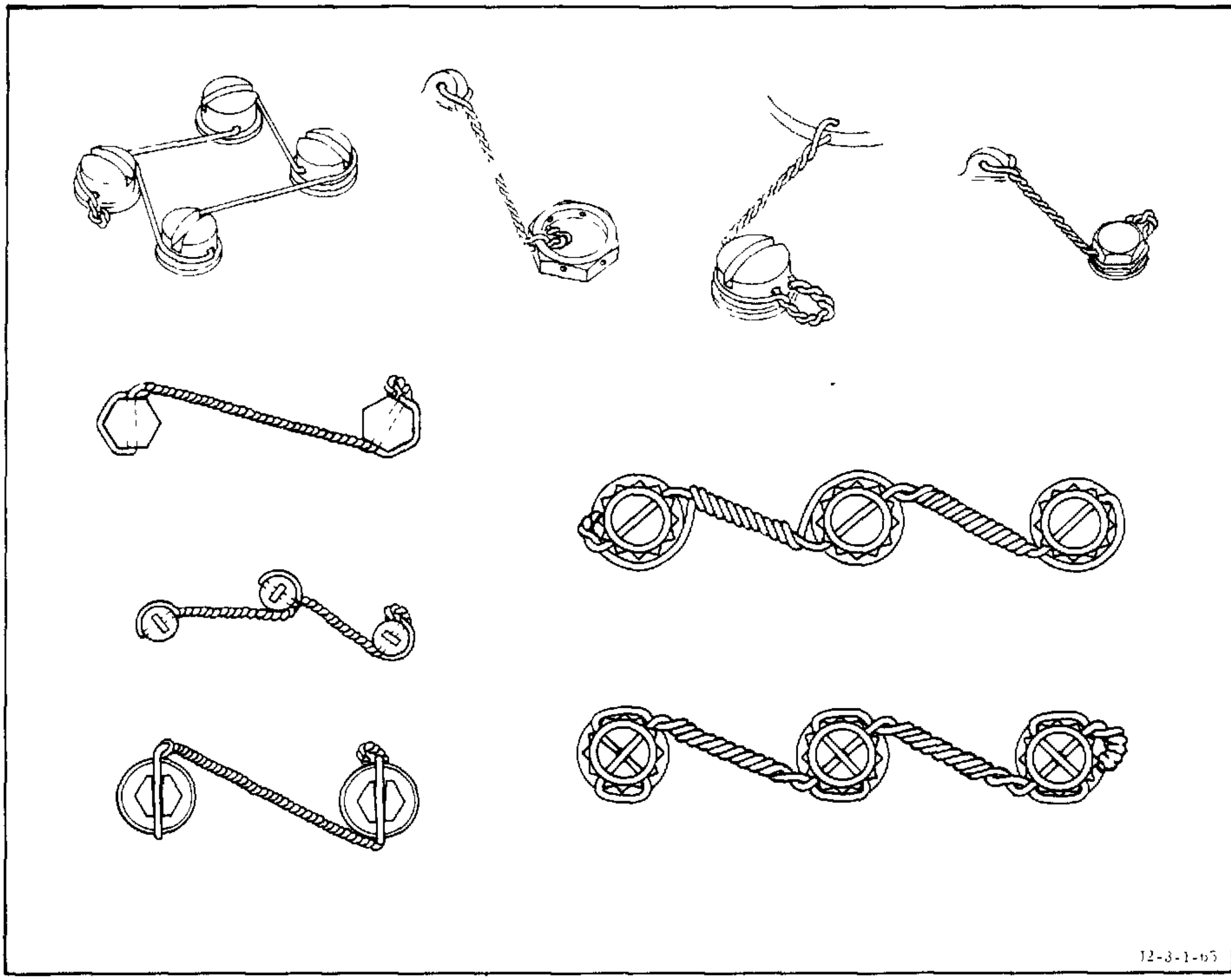


Figure 1-7. Safetywiring Methods

Lightweight Inserts						
		Installation Data			Removal Data	
		Tap (UNC-2B)				
Insert Number (Internal Thread)	NAS Number	Size	Min Depth (Inch)	Tool Number	Drill Size (Inch)	Drill Depth (Inch)
KNL 0832	NAS1394C-08L	1/4-20	0.31	TD 0832L	3/16	1/8
KN 428T-DFL	NAS1394C-4	3/8-16	0.43	TD 428L	9/32	3/16
KN 524-MXSY	NAS1394C-5	7/16-14	0.50	TD 524L	11/32	3/16
KN 524T-7SP	NAS1394C-5	7/16-14	0.50	TD 524L	11/32	3/16
KN 624T	NAS1394C-6	1/2-13	0.56	TD 624L	13/32	3/16
KN 624T-DFL	NAS1394C-6	1/2-13	0.56	TD 624L	13/32	3/16

Figure 1-8. Keenserts Insert Removal and Installation Data (Sheet 1 of 2)

Heavy-Duty Inserts						
		Installation Data			Removal Data	
		Tap (UNC-2B)				
Insert Number (Internal Thread)	NAS Number	Size	Min Depth (Inch)	Tool Number	Drill Size (Inch)	Drill Depth (Inch)
KNH 524-MX	NAS1395C-5	1/2-13	0.50	THD 524L	13/32	3/16
KNH 524-MXSY	NAS1395C-5	1/2-13	0.50	THD 524L	13/32	3/16
KNH 720-MX	NAS1395C-7	5/8-11	0.68	THD 720L	17/32	3/16
KNH 720-MXSY	NAS1395C-7	5/8-11	0.68	THD 720L	17/32	3/16

Miniature Inserts					
	Installation Data			Removal Data	
	Tap (UN-2B)				
Insert Number	Size	Min Depth (Inch)	Tool Number	Drill Size (Inch)	Drill Depth (Inch)
KCCL 0256	6-32	0.13	TKCC 02	0.106	1/16
KCL 0256	8-32	0.15	TKC 02	0.100	1/16
KCL 0632	12-28	0.21	TKC 06	0.158	3/32
KCL 0832	1/4-28	0.21	TKC 08	0.199	3/32

Miniature Inserts					
	Installation Data			Removal Data	
	Tap (UNF-2A)				
Insert Number	Size	Min Depth (Inch)	Tool Number	Drill Size (Inch)	Drill Depth (Inch)
KNCL 0256	8-32	0.140	TKNC 02	0.113	1/16
KNCL 0632	12-28	0.160	TKNC 06	0.159	3/32

Figure 1-8. Keenserts Insert Removal and Installation Data (Sheet 2 of 2)

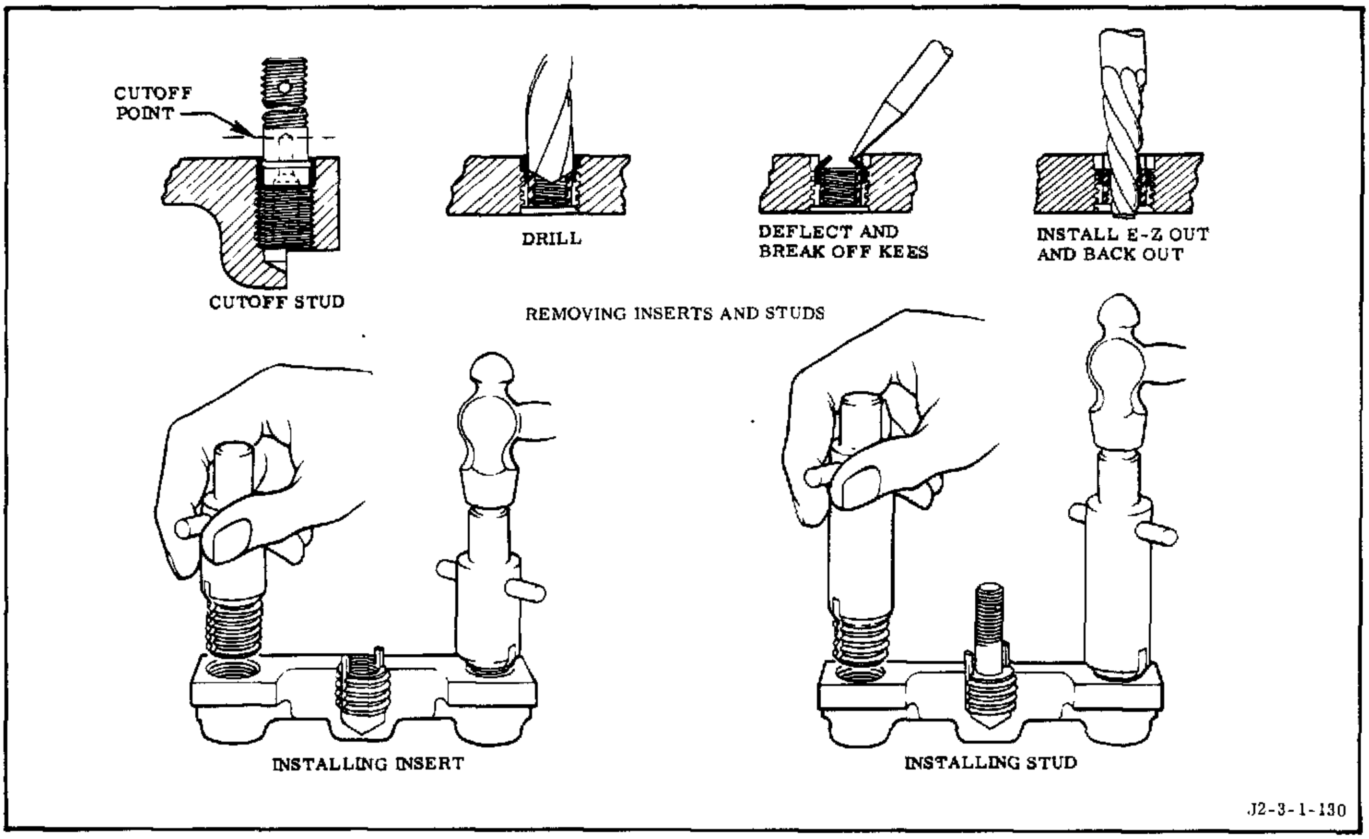


Figure 1-9. Removing and Installing Keenserts Inserts and Studs

1-52. INSTALLING KEENSERTS INSERTS.

WARNING

Contaminated parts used in a direct or indirect liquid oxygen system can cause an explosion, resulting in serious injury to personnel and damage to equipment.

a. Clean all parts for service in applicable engine system.

b. Select correct replacement insert. See figure 1-8 for tap size and installing tool for insert selected.

c. If necessary, chase threads to remove burs.

d. Clean tapped hole to remove all chips.

e. Install insert by turning with fingers or fit kees into tool slots and turn tool. (See figure 1-9.)

f. Install insert to a depth of 0.010 to 0.030 inch below surface of parent metal. Aline insert kees with original slots in parent metal. If insert is being installed in material having an ultimate strength of less than 80,000 psig and insert kees cannot be alined with original slots in parent metal, new slots will be broached when kees are driven in. If insert is installed in material having an ultimate strength of 80,000 psig or more and insert kees cannot be alined with original slots within depth tolerance of 0.010 to 0.030, broach new kee slots as follows:

(1) Install insert to depth of 0.010 to 0.030 inch below surface of parent metal, and index kees to parent metal by suitable marking.

(2) Remove insert, and install proper broaching tool to aline cutting edges with index marking on parent metal.

NOTE

Broaching tools are identified by adding prefix "B" to insert or stud part number (example: B KN 524).

(3) Using arbor press or equivalent tool, broach new kee slots in parent metal.

(4) Reinstall insert to a depth of 0.010 to 0.030 inch below surface of parent metal. Aline insert kees with broached slots in parent metal.

g. Lift and turn installing tool until slots clear kees. Drive in kees using a hammer or an arbor press and installing tool.

1-53. REMOVING KEENSERTS STUDS. (See figure 1-9.)

a. Cut off stud just above parent metal.

NOTE

On most studs with nut-end thread sizes of 1/4 inch and larger, an internal pilot hole will be exposed and steps b, d, and e must be accomplished. If the stud is not provided with an internal pilot hole, steps c, d, and e must be accomplished.

b. Drill out pilot hole to diameter and depth indicated in Removal Data column of figure 1-10.

c. Center-punch stud to start drill and drill to diameter and depth indicated in Removal Data column of figure 1-10.

d. Deflect exposed portion of kees inwardly and break off kees.

e. Drive in E-Z Out type extraction tool and back out stud.

1-54. INSTALLING KEENSERTS STUDS. Keenserts studs are installed in the same order and manner as Keenserts inserts except that the installing tool has an internal pilot hole to fit over the stud. (See figures 1-9 and 1-10.)

1-55. REMOVING HELI-COIL INSERTS.

a. Select extracting tool for insert to be removed, from figure 1-11.

b. Place extracting tool blade into first turn of insert so that one side of blade is 45-90 degrees from end of top coil of insert. (See figure 1-12.)

c. Tap top of tool lightly with hammer so that edge of blade imbeds, gripping insert.

d. Apply heavy hand pressure on tool simultaneously rotating tool counterclockwise until insert is removed.

	Heavy-Duty Studs				
	Installation Data			Removal Data	
	Tap (UN-2B)				
Part Number of Nut End Thread	Size	Min Depth (Inch)	Tool Number	Drill Size (Inch)	Drill Depth (Inch)
KNHS 428T-26	7/16-14	0.43	THS 4	11/32	3/16
KNHS 524T-18	1/2-13	0.50	THS 5	13/32	3/16
KNHS 624T-19SP	9/16-12	0.56	THS 6	15/32	3/16

	Lightweight Studs				
	Installation Data			Removal Data	
	Tap (UNC-2B)				
Part Number of Nut End Thread	Size	Min Depth (Inch)	Tool Number	Drill Size (Inch)	Drill Depth (Inch)
KNNS 428T-17	3/8-16	0.43	TNS 4	9/32	3/16

	Lightweight Studs				
	Installation Data			Removal Data	
	Tap (UNS-2A)				
Part Number of Nut End Thread	Size	Min Depth (Inch)	Tool Number	Drill Size (Inch)	Drill Depth (Inch)
RD-32 (1/4-28 UNF-3A)	3/8-16	0.37	TNS 4	9/32	3/16

Figure 1-10. Keenserts Stud Removal and Installation Data

Insert Internal Nominal Thread Size	Steel STI Tap Numbers	Threaded Plug Gage Numbers		Insert Inserting Tool Numbers		Insert Tang Breakoff Tool Numbers		Insert Extracting Tool Numbers
	Bottoming Style	Working Gage	Inspection Gage	Plain	Mid-Grip	Plain	Mid-Grip	
#4-40UNC-3B	27187-04	3688-04	1688-04	7551-04	7551-04	3695-04	3695-04	
#6-32UNC-3B	27187-06	3688-06	1688-06	7551-06	7551-06	3695-06	3695-06	1227-06
#6-40UNF-3B	27193-06	3694-06	1694-06	7552-06	7552-06	3695-06	3695-06	
#8-32UNC-3B	27187-2	3688-2	1688-2	7551-2	7551-2	3695-2	3695-2	
#10-32UNF-3B	27193-3	3694-3	1694-3	7552-3	7552-3	3695-3	3695-3	
1/4-28UNF-3B	5193-4	3694-4	1694-4	7552-4	7552-4	3695-4	3695-4	1227-6
5/16-24UNF-3B	5193-5	3694-5	1694-5	7552-5	7552-5	1297-5	3601-5	
3/8-24UNF-3B	5193-6	3694-6	1694-6	7552-6	7552-6	1297-6	3601-6	
7/16-20UNF-3B	44193-7	3694-7	1694-7	7552-7	7552-7	1297-7	3601-7	
1/2-20UNF-3B	44193-8	3694-8	1694-8	7552-8	7552-8	1297-8	3601-8	1227-16
9/16-18UNF-3B	44193-9	--	1694-9	7552-9	7552-9	1196-9	1196-9	

Figure 1-11. Heli-Coil Insert Removal and Installation Tools

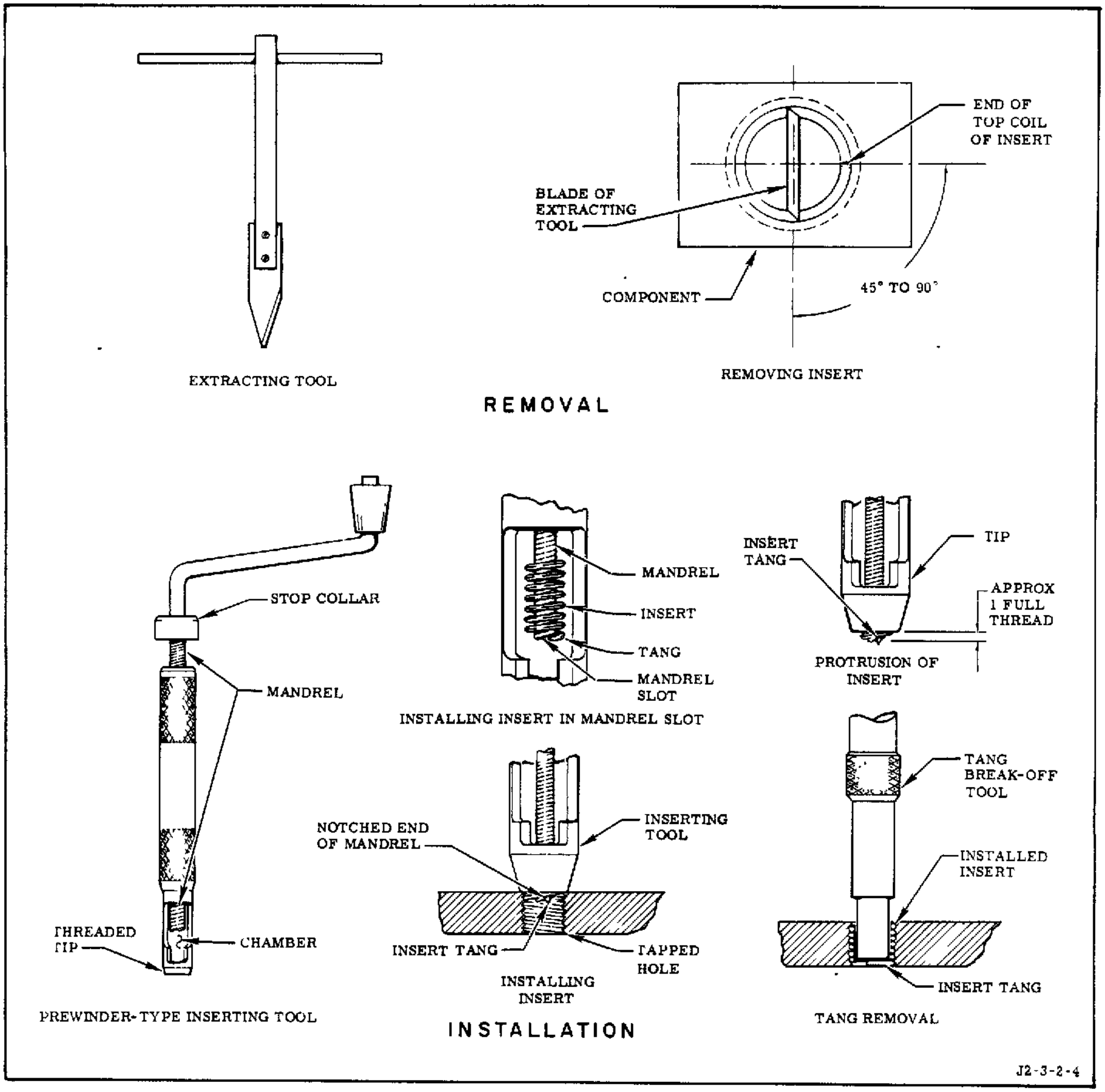


Figure 1-12. Removing and Installing Heli-Coil Inserts

1-56. INSTALLING HELI-COIL INSERTS.

a. Clean all parts for applicable service in engine system.

WARNING

Contaminated parts used in a direct or indirect liquid oxygen system can cause an explosion, resulting in serious injury to personnel and damage to equipment.

b. Select correct replacement insert from figure 1-13.

c. Obtain Heli-Coil STI tap, inserting tool, and tang breakoff tool indicated for insert in figure 1-11.

d. If necessary, chase threads in tapped hole to remove burs.

e. Clean tapped hole to remove all chips.

f. Gage tapped hole threads with working gage specified in figure 1-11. Use inspection gage if working gage is not available.

g. Adjust stop collar on mandrel to touch tool body when mandrel protrudes through prewinder a distance equal to the nominal length of insert plus 1/2 thread.

h. Retract mandrel by turning it counterclockwise. Place insert in chamber and hold insert with finger to prevent it from filling out; then rotate mandrel clockwise to thread insert onto mandrel.

i. Continue rotating mandrel clockwise until insert protrudes beyond tip of tool approximately one full thread.

j. Place tool squarely and firmly against tapped hole in component. Rotate mandrel clockwise at a uniform rate until stop collar just contacts tool body and insert is installed 3/4 to 1-1/2 pitches below surface.

k. Rotate mandrel counterclockwise until it is free of insert; then check depth of insert installation.

l. If necessary, readjust stop collar on mandrel and repeat step i until insert is properly installed.

m. If original insert had tang removed, snap off tang of replacement insert by holding automatic breakoff tool against insert tang; then press preloaded barrel down to release striking punch. If manual breakoff tool is used, remove insert tang by holding breakoff tool against tang and striking the protruding rod of tool with hammer. Remove broken insert tang from hole. (See figure 1-12.) For insert sizes over one inch, use long-nose pliers bending tang up and down to break off tang at notch, and remove tang.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

- The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

n. Remove red dye from mid-grip insert prior to installation in components used for liquid oxygen service. Remove dye with methyl-ethyl-ketone (Federal Specification TT-M-261). Clean insert after dye removal by handwiping with clean trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533).

o. Inspect installed insert by inserting a bolt or screw of applicable size into insert to a depth of 4 complete turns after contacting locking device. Bolt or screw should turn freely by hand until locking device is contacted. Remove bolt or screw.

p. Inspect insert for proper installation depth and contamination.

CAUTION

Installing bolts in inserts that contain chips or foreign matter can cause galling of the bolt and/or insert resulting in incorrect installation of the bolt.

q. If contamination (chips or foreign matter) is found on inserts, remove with a vacuum cleaner.

1-57. REMOVING ROSAN LOCKRING THREADED INSERTS.

a. Use removal drill specified in figure 1-14.

b. Drill swage lock portion of insert to counterbore depth plus 0.025 inch. (See figure 1-15 for counterbore depth.)

c. Remove remaining swage lock portion of insert with punch. (See figure 1-15.)

d. Using drive wrench, remove insert. (See figure 1-15.)

e. Clean out hole.

Plain Nonbolt Locking-Type Inserts

Internal Thread Size	Length (Inch)	Part Number: Commercial	Part Number: New Coordinated Military Standards	Part Number: Military Standards
4-40	0.224	1185-04CNV 0224	21208-C0420	MS122156
6-32	0.207	1185-06CNV 0207	21208-C0615	MS122118
8-32	0.246	1185-2CNV 0246	21208-C0815	MS122119
10-32	0.285	1191-3CNV 0285	21208-F1-15	MS124695
10-32	0.380	1191-3CN 0380	21208-F1-20	MS124735
1/4-28	0.250	1191-4CNV 0250	21208-F4-10	MS124656
1/4-28	0.375	1191-4CNV0375	21208-F4-15	MS124696
1/4-28	0.500	1191-4CNV 0500	21208-F4-20	MS124736
5/16-24	0.469	1191-5CNV 0469	21208-F5-15	MS124697
3/8-24	0.562	1191-6CN 0562	21208-F6-15	MS124698
3/8-24	0.750	1191-6CN 0750	21208-F6-20	MS124738
7/16-20	0.438	1191-7CNV 0438	21208-F7-10	MS124659
1/2-20	0.750	1191-8CNV 0750	21208-F8-15	MS124700
9/16-18	0.562	1191-9CN 0562	21208-F9-10	MS124661
9/16-18	0.844	1191-9CNV 0844	21208-F9-15	MS124701

Mid-Grip Bolt Locking-Type Inserts

Internal Thread Size	Length (Inch)	Part Number: Commercial	Part Number: New Coordinated Military Standards
4-40	0.224	3585-04CNV 0224	21209-C0420
6-32	0.207	3585-06CNV 0207	21209-C0615
6-32	0.276	3585-06CNV 0276	21209-C0620
6-40	0.138	3591-06CN 0138	--
8-32	0.246	3585-2CNV 0246	21209-C0815
8-32	0.328	3585-2CNV 0328	21209-C0820
10-32	0.285	3591-3CNP 0285	21209-F1-15
10-32	0.285	3591-3CNV 0285	21209-F1-15
10-32	0.380	3591-3CNV 0380	21209-F1-20
1/4-28	0.375	3591-4CNV 0375	21209-F4-15
1/4-28	0.500	3591-4CN 0500	21209-F4-20
5/16-24	0.469	3591-5CNV 0469	21209-F5-15
5/16-24	0.625	3591-5CNV 0625	21209-F5-20
3/8-24	0.562	3591-6CNV 0562	21209-F6-15
7/16-20	0.438	3591-7CNV 0438	--
7/16-20	0.656	3591-7CNV 0656	21209-F7-15
1/2-20	0.750	3591-8CNV 0750	21209-F8-15
9/16-18	0.562	3591-9CNV 0562	--

V = silver plate
P = cadmium plate

Figure 1-13. Heli-Coil Insert Size, Length, and Part Number

Rosan Slimsert Inserts							
		Plug Tap	Bottoming Tap				
Insert Part Number	Tap -3B Mod	Min Full Thread (Inch)	Min Full Thread (Inch)	Drive Wrench	Swage Tool	Counter-bore Depth (Inch)	Removal Drill (Inch)
SR 086	6-40 UNF Not Mod	0.160	0.160	SR08W4-A	SR 08S	0.040	0.1285

Figure 1-14. Rosan Insert Removal and Installation Data

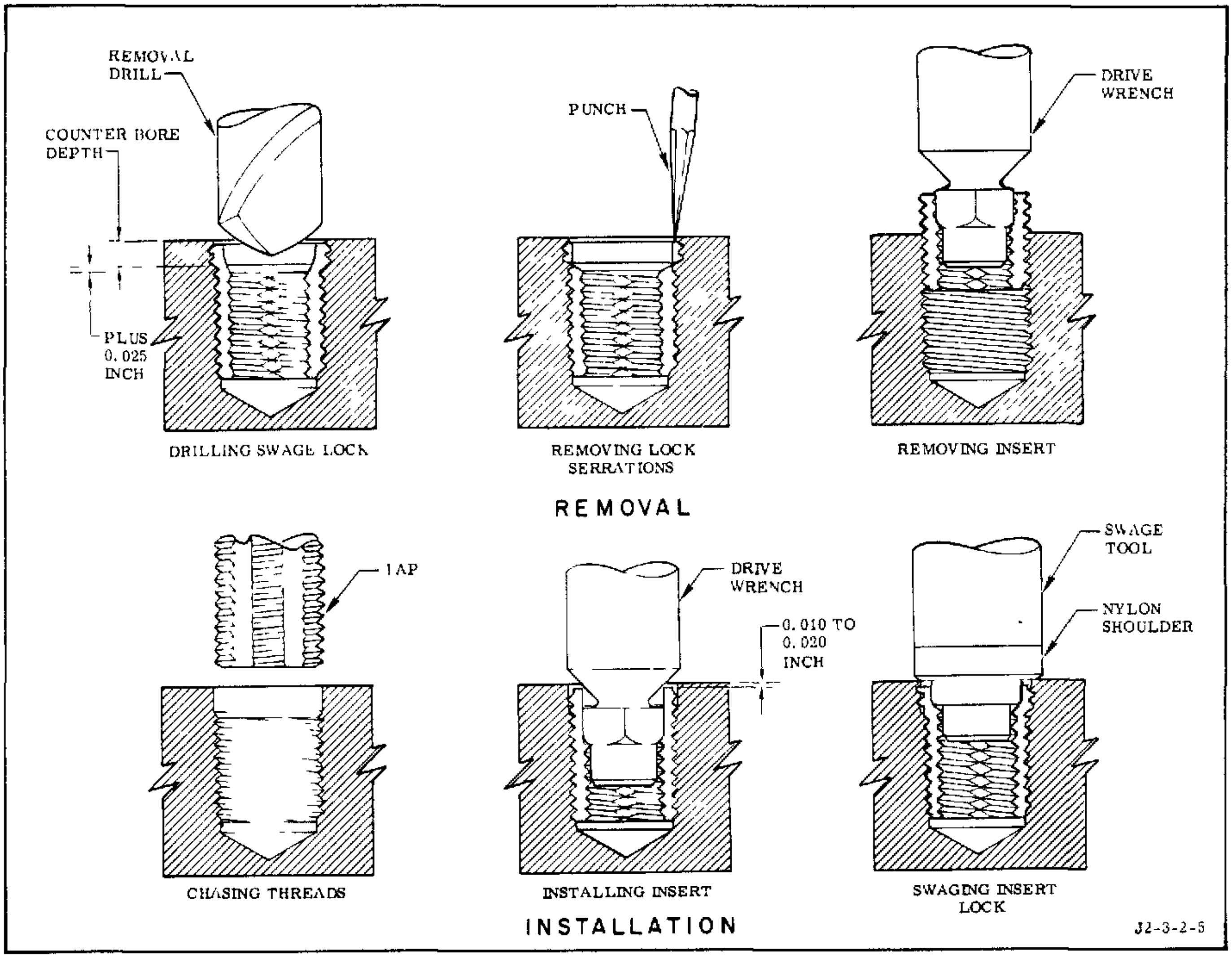


Figure 1-15. Removing and Installing Rosan Inserts

1-58. INSTALLING ROSAN LOCKRING THREADED INSERTS.

a. Clean all parts for applicable service in engine system.

WARNING

Contaminated parts used in a direct or indirect liquid oxygen system can cause an explosion, resulting in serious injury to personnel and damage to equipment.

b. See figure 1-14 for tap size and installing tools.

c. If necessary, chase threads in tapped hole to remove burs. (See figure 1-15.)

d. Clean tapped hole to remove all chips.

e. Using drive wrench, install insert 0.010 to 0.020 inch below surface of parent metal. (See figure 1-15.)

f. Place swaging tool in insert and apply downward force sufficient to bottom nylon shoulder of swaging tool on surface of parent metal. This will effect full swageout and external lock setting of insert.

1-59. TIMING ENGINE VALVES.

1-60. Engine valve-delay and valve-motion times are controlled by orifices located in the pneumatic control system. Paragraphs 1-61 through 1-76 contain the timing criteria and the orificing procedures for adjusting the valve times. Refer to R-3825-1B for location and nominal size of pneumatic control system orifices. Orificing is accomplished only after thorough analysis of a timing problem indicates orificing is necessary.

1-61. TIMING GAS GENERATOR CONTROL VALVE.

1-62. The gas generator control valve opening time is controlled by an orifice plate located at the main oxidizer valve sequence outlet port. A 0.001-inch change of the orifice size changes the opening time approximately 5 milliseconds. Valve closing time is determined by the venting rate of the fast-shutdown valve. (Refer to paragraph 1-71 for orificing procedure.)

1-63. TIMING MAIN OXIDIZER VALVE.

1-64. The main oxidizer valve timing is controlled by an orifice plate at the second-stage opening port and a thermostatic orifice check valve assembly on the closing side of the valve actuator. The opening and closing times are adjusted as follows:

a. First-stage opening time is fixed by design and cannot be adjusted.

b. (Deleted)

c. Second-stage opening delay and ramp time is adjusted by changing the size of orifice in thermostatic orifice check valve assembly. (Refer to paragraph 1-75 for orificing procedure and orifice size requirements.)

d. Valve closing time is adjusted by changing the size of orifice plate at second-stage opening port. A 0.001-inch change of orifice size changes delay time approximately 2-3 milliseconds and ramp time approximately 5 milliseconds. (Refer to paragraph 1-71 for orifice procedure.)

1-65. TIMING MAIN FUEL VALVE.

1-66. The main fuel valve opening, closing, and delay times are controlled by an orifice plate located at the opening control port. A 0.001-inch change of the orifice size changes the delay time approximately 2-3 milliseconds and the opening and closing ramp times approximately 5 milliseconds. (Refer to paragraph 1-71 for orificing procedure.)

Figures 1-16 and 1-17 deleted.

1-67. TIMING OXIDIZER TURBINE BYPASS VALVE.

1-68. The oxidizer turbine bypass valve opening time is controlled by a restrictor valve at the main oxidizer valve sequence outlet port, and the closing time is controlled by an orifice plate at the oxidizer turbine bypass valve opening control port. The opening and closing times are adjusted as follows:

a. Opening time is adjusted by changing the size of the restrictor valve poppet. (The restrictor valve is in the main oxidizer valve sequence valve outlet tube.) A 0.001-inch change of orifice size changes opening time approximately 100 milliseconds. (Refer to paragraph 1-73 for orificing procedure.)

b. Closing time is adjusted by changing the orifice size of the orifice plate at the oxidizer turbine bypass valve opening control port. A 0.001-inch change of orifice size changes closing time approximately 10 milliseconds. Minimum size of the orifice in this plate is 0.035 inch. (Refer to paragraph 1-71 for orificing procedure.)

1-69. TIMING START TANK DISCHARGE VALVE.

1-70. The start tank discharge valve (STDV) closing time is controlled by a restrictor valve in the STDV control valve adapter. STDV timing is adjusted by changing the orifice size in the restrictor valve orifice plug. On engines with STDV 306875, the opening time is fixed by design and no adjustment is required. On engines with STDV 304386 (installed as a spare or on engines incorporating MD275 change) the opening time is not fixed and can be adjusted by orifice size. On STDV 304386 a 0.001-inch change in orifice size changes the opening time approximately one millisecond and changes the closing time approximately 5 milliseconds. On STDV 306875, a 0.001-inch change of the orifice size changes the closing time approximately 10 milliseconds. (Refer to paragraph 1-73 for orificing procedures.)

1-71. ORIFICING ORIFICE PLATES.

1-72. The orifice plate is a removable metal plate located between the flanges of the valve port and the connecting tube assembly. Refer to R-3825-1B for location and nominal size of pneumatic control system orifice plates. Refer to the applicable valve timing paragraph in this section for timing criteria and to engine sequence testing in section IV for specified valve times. A comparator, to measure orifice size, is required for this task.

a. Remove bolts and washers connecting tube assembly, and remove orifice plate and seal.

b. Using comparator, measure existing orifice diameter at 3 places, approximately 120 degrees apart. Average the 3 measurements to determine effective orifice size.

c. If actual valve time is less than specified time, determine new orifice size as follows:

(1) Subtract actual valve time from nominal specified time. Record difference as change in valve time.

(2) Using timing criteria for applicable valve (paragraphs 1-61 through 1-67), determine change in orifice size required to obtain change in valve time.

(3) Subtract change in orifice size from effective orifice size determined in step b. Record result as new effective orifice size.

d. If actual valve time exceeds specified time, determine new orifice size as follows:

(1) Subtract nominal specified time from actual valve time. Record difference as change in valve time.

(2) Using timing criteria for applicable valve (paragraphs 1-61 through 1-67), determine change in orifice size required to obtain change in valve time.

(3) Add change in orifice size to effective orifice size determined in step b. Record result as new effective size.

e. If new effective size is smaller than calculated size, proceed to step g. If new effective size is larger, obtain new orifice plate and proceed to step f.

CAUTION

If the orifice plate is clamped in a holding device, surface damage can result and impair its function.

f. Using drill slightly smaller than calculated orifice size, drill orifice. Do not clamp orifice plate in holding device.

g. Measure orifice size as outlined in step b. If effective size is satisfactory, proceed to step l. If size is smaller than calculated size, lap orifice as outlined in steps h through k.

CAUTION

Using a straight-shank drill for lapping an orifice to proper size as outlined in steps h through k will result in a tapered orifice bore unless the flute end of the drill is short enough to permit the jaws of the drill chuck to clamp solidly on the drill shank.

h. Select a short length of drill rod or a straight shank drill the same size as orifice or next smaller size.

i. Insert drill rod or drill (twist end first) into drill motor chuck. Coat exposed rod or drill shank with 600-grit lapping compound.

j. Start drill motor, insert rod or drill shank in orifice, and lap orifice to larger opening.

k. Repeat steps b and j until orifice is desired size.

kA. Using electrochemical etch method obliterate existing dash number of part number on orifice plate and add new 4-digit dash number designating new diameter of orifice.

l. Clean orifice plate for propellant and pneumatic service.

m. Visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation (paragraph 1-49).

n. Install orifice plate and seal between tube assembly and valve port using bolts and washers. Orifices must be installed with the orifice positioned as shown in figure 1-18. Torque bolts to 41-45 in-lb and safetywire.

o. Leak-test disconnected flanges by performing pneumatic control system test, and check applicable valve time by performing engine sequence test. (Refer to section IV for testing.)

p. If valve times are satisfactory, proceed to step q; if not, repeat steps a through o, then proceed to step q.

q. Record new orifice size in engine records.

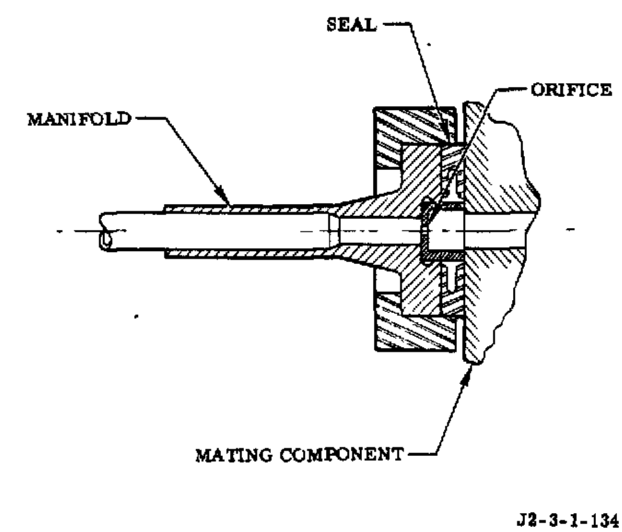


Figure 1-18. Orifice Installation

r. Identify new orifice size by obliterating old orifice size number and stamping or embossing new orifice size number on orifice identification tag. The old tag may be removed and a new tag, containing the orifice size identification, installed in the same location.

1-73. ORIFICING RESTRICTOR VALVES.

1-74. The restrictor valves contain an orificed plug or an orificed guide that allows orificing in the free-flow direction and an orificed poppet that allows orificing in the reverse-flow direction. Refer to R-3825-1B for location and nominal size of pneumatic control system restrictor valves. See figure 1-18A for restrictor valve details. Refer to the applicable valve timing paragraph in this section for timing criteria, and to engine sequence testing in section IV for specified valve times. A comparator, to measure orifice size, is required for this task.

a. Remove bolts, washers, and seal that secure restrictor valve to component.

b. On restrictor valve 556426, remove orifice plug, guide, spring, and poppet from body of valve.

c. On restrictor valves 556427 and 558020, remove orifice guide, spring, and poppet from body of valve.

d. Using comparator, measure existing orifice diameter at 3 places approximately 120 degrees apart. Average the 3 measurements to determine effective orifice size.

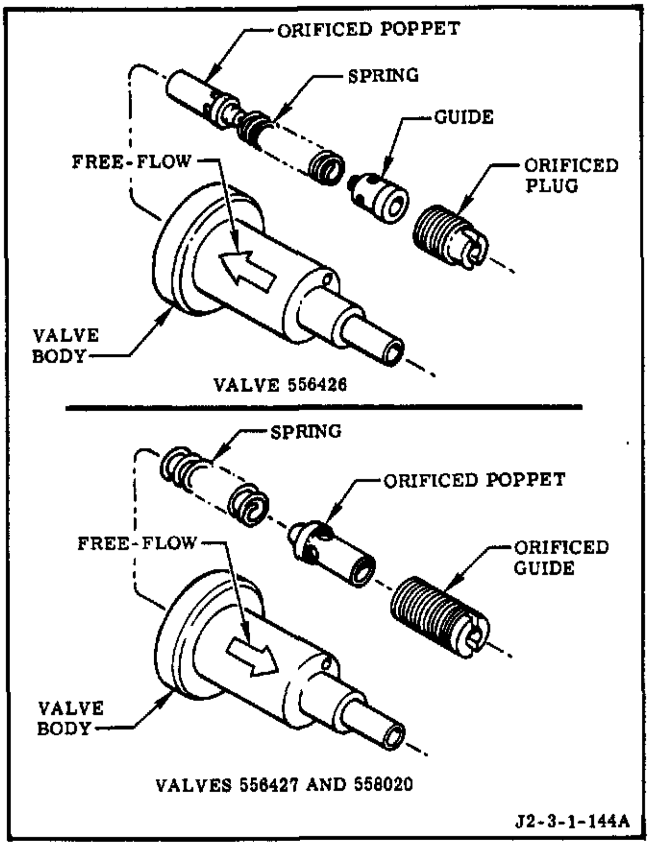


Figure 1-18A. Restrictor Valves

e. If actual valve time is less than specified time, determine new orifice size as follows:

(1) Subtract actual valve time from nominal specified time. Record difference as change in valve time.

(2) Using timing criteria for applicable valve (paragraphs 1-63, 1-64, and 1-67 through 1-70), determine change in orifice size required to obtain change in valve time.

(3) Subtract change in orifice size from effective size determined in step d. Record result as new effective orifice size.

f. If actual valve time exceeds specified time, determine new orifice size as follows:

(1) Subtract nominal specified time from actual valve time. Record difference as change in valve time.

(2) Using timing criteria for applicable valve (paragraphs 1-63, 1-64, and 1-67 through 1-70), determine change in orifice size required to obtain change in valve time.

(3) Add change in orifice size to effective orifice size determined in step d. Record result as new effective size.

NOTE

An undamaged plug, guide, or poppet with an orifice smaller than the calculated size may be used.

g. If new effective size is smaller than calculated size, proceed to step h. If new effective size is larger, obtain new orifice plug, guide, or poppet (as applicable) and proceed to step i.

CAUTION

If the poppet, plug, or guide is clamped in a holding device, surface damage can result and impair its function.

h. Using drill slightly smaller than calculated orifice size, drill orifice. Do not clamp orifice plug, guide, or poppet (as applicable) in holding device.

i. Measure orifice size as outlined in step d. If effective size is satisfactory, proceed to step n. If size is smaller than calculated size, lap orifice as outlined in steps j through m.

CAUTION

Using a straight-shank drill for lapping an orifice to proper size as outlined in steps j through m will result in a tapered orifice bore unless the flute end of the drill is short enough to permit the jaws of the drill chuck to clamp solidly on the drill shank.

j. Select a short length of drill rod or a straight-shank drill the same size as orifice or next smaller size.

k. Insert drill rod or drill (twist end first) into drill motor chuck. Coat exposed rod or drill shank with 600-grit lapping compound.

l. Start drill motor, insert rod or drill shank in orifice, and lap orifice to larger opening.

m. Repeat steps d and l until orifice is desired size.

n. Clean orifice restrictor valve components for propellant and pneumatic service.

nA. On restrictor valve 556426, reinstall poppet, spring, guide, and orifice plug in restrictor body and torque orifice plug to 10-15 in-lb. If diameter of orifice in poppet is same or larger than diameter of orifice in plug, poppet, spring, and guide may be omitted from assembly.

nB. On restrictor valves 556427 and 558020, reinstall poppet, spring, and orifice guide in restrictor body and torque orifice guide to 7-10 in-lb. If diameter of orifice in poppet is same or larger than diameter of orifice in guide, poppet and spring may be omitted from assembly.

o. Visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation (paragraph 1-49).

p. Install restrictor valve and seal on valve port and secure with bolts and washers. Torque bolts to 41-45 in-lb. Do not safetywire bolts at this time.

q. Leak-test disconnected flanges by performing pneumatic control system test, and check applicable valve time by performing engine sequence test. (Refer to section IV for testing.)

r. If valve timing is not satisfactory, repeat steps a through q, as applicable. If valve timing is satisfactory, safetywire bolts installed in step p.

CAUTION

Impression-stamping can damage the restrictor valve.

s. Using electrochemical etch method, reidentify restrictor valve or valve body and orifice identification tag (if used), as follows:

(1) If internal components were omitted from assembly as permitted in steps nA and nB, cross out both dash numbers, add AA below first old dash number, and add new dash number (new effective size) of remaining orifice below second old dash number.

(2) If valve was reorificed for reverse-flow direction, cross out first dash number and add new dash number (new effective size) below old number.

(3) If valve was reorificed for free-flow direction, cross out second dash number and add new dash number (new effective size) below old number.

NOTE

Old orifice identification tag may be replaced with new tag which has been prepared in same manner and installed in same location as old tag.

t. Record new orifice size in engine records.

1-75. ORIFICING MAIN OXIDIZER VALVE THERMAL-COMPENSATING ORIFICE CHECK VALVE.

1-76. The main oxidizer valve incorporates a thermal-compensating orifice in the closing side of the actuator. The thermal-compensating orifice controls the venting pressure from the closing side of the actuator to maintain a constant valve opening time at ambient and cryogenic temperatures. (Refer to engine sequence testing in section IV for specified valve times.)

a. Remove orifice and compensator as follows: (See figure 1-19.)

(1) Remove bolts (1), washers (2), cover (3), and seal (4) from cap (5). Remove plug (6) from cover (3).

(2) Remove nut (7) from cap.

(3) Remove spacer (8) from cap.

CAUTION

Only a magnet is to be used to remove the orifice and compensator, since wire or other tools can damage orifice and compensator.

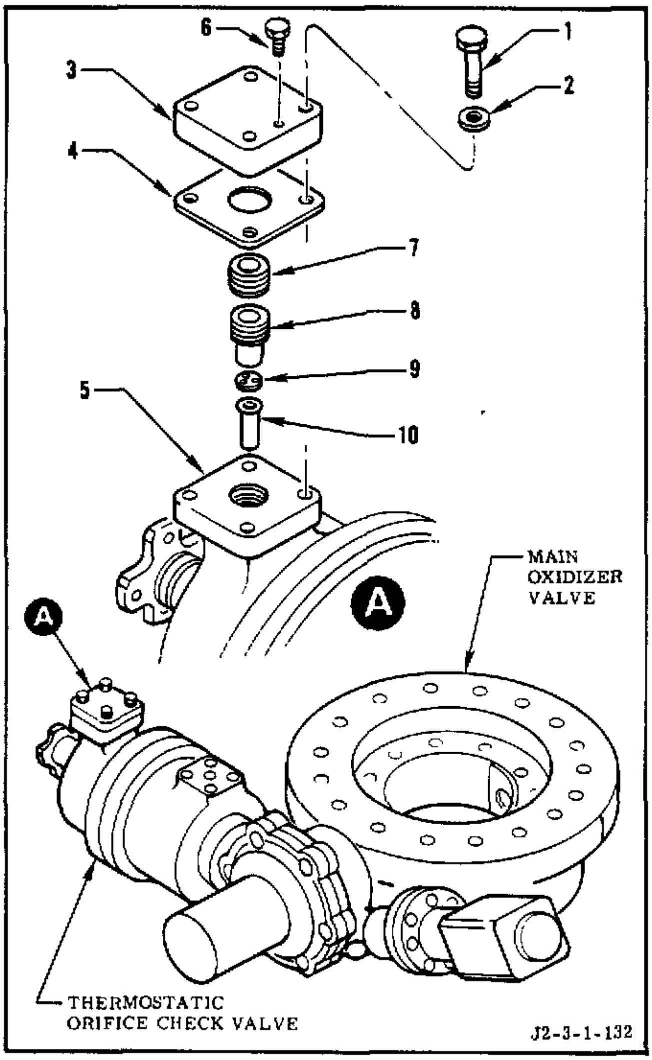
(4) Using magnet, remove orifice (9) and compensator (10) from cap.

b. If main oxidizer valve second-stage opening time (valve motion time) exceeds specified maximum time, determine new orifice size as follows:

(1) Subtract nominal specified valve motion time from actual valve motion time. The difference is change in valve motion time.

(2) See figure 1-20 and determine change in orifice flowrate required to obtain change in valve motion time.

(3) Add change in orifice flowrate to flowrate marked on existing orifice identification tag. Result is new orifice flowrate required to obtain specified valve time. See figure 1-21 and determine new orifice number.



Index Number	Nomenclature
1	Bolt
2	Washer
3	Cover
4	Seal
5	Cap
6	Plug
7	Nut
8	Spacer
9	Orifice
10	Compensator

Figure 1-19. Main Oxidizer Valve Thermal-Compensating Orifice Check Valve

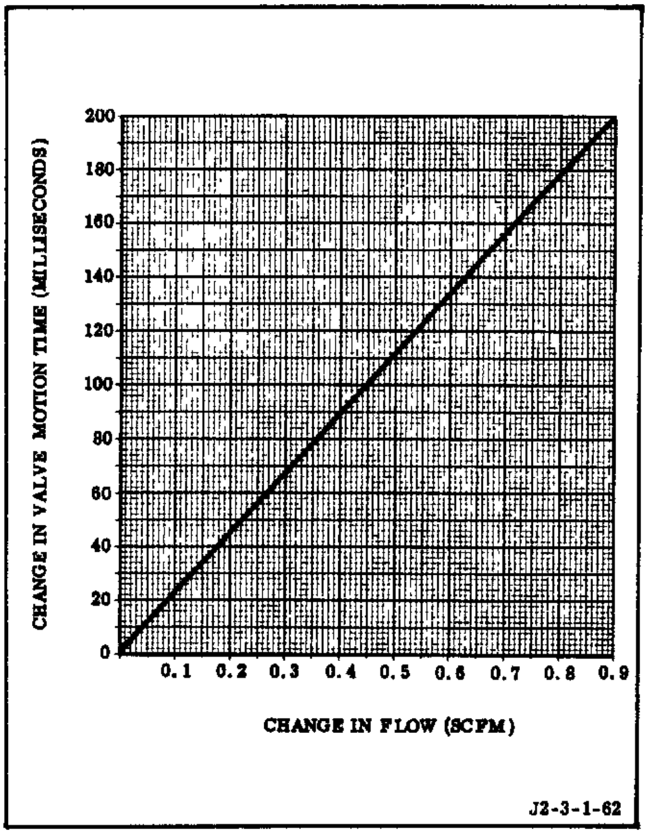


Figure 1-20. Change in Valve Motion Time Versus Change in Flow

c. If main oxidizer valve second-stage opening time (valve motion time) is less than specified minimum time, determine new orifice time as follows:

(1) Subtract actual valve motion time from nominal specified valve motion time. The difference is change in valve motion time.

(2) See figure 1-20 and determine change in orifice flowrate required to obtain change in valve motion time.

(3) Subtract change in orifice flowrate from flowrate marked on existing orifice identification tag. Result is new orifice flowrate required to obtain specified valve time. See figure 1-21 and determine new orifice number.

d. Visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation (paragraph 1-49). Install orifice and compensator as follows: (See figure 1-19.)

(1) Clean all components to be installed for propellant and pneumatic service before reassembly.

CAUTION

Installing the compensator and orifice separately can result in contamination becoming lodged between the compensator and orifice, causing damage to components.

(2) Inspect compensator (10), orifice (9), and spacer (8) for damage and contamination prior to installation. Center orifice with letters "UP" visible on compensator; and using a magnet, install orifice and compensator together in cap (5). When compensator bottoms, hold orifice in place with a clean nonmagnetic rod, and remove magnet and rod. Make sure orifice is centered and lying flat on compensator. Install spacer (8) in cap (5). Torque spacer to 30-35 in-lb.

(3) Install nut (7) into cap. Torque nut to 30-35 in-lb.

(4) Install seal (4) and cover (3), and secure with washers (2) and bolts (1).

(5) Torque bolts to 72-88 in-lb and safety-wire.

(6) Perform pneumatic control system test (helium-control phase), and leak-test cap (5); then perform engine sequence test to determine if valve time is within tolerance. (See section IV for testing.)

(7) Install plug (6) in leak-test port of cover (3).

e. Remove old orifice identification tag and install new orifice identification tag (in same location) with new orifice number, flowrate (in scfm), date, and valve serial number.

Orifice 410437 Dash Number	Flowrate (scfm)
-078	7.70 to 7.89
-080	7.90 to 8.09
-082	8.10 to 8.29
-084	8.30 to 8.49
-086	8.50 to 8.69
-088	8.70 to 8.89
-090	8.90 to 9.09
-092	9.10 to 9.29

Figure 1-21. Table of Orifice Dash Numbers Versus Flowrates

1-77. INSPECTION AND INSTALLATION REQUIREMENTS AND CRITERIA FOR ELECTRICAL HARNESS SUPPORT AND BONDING CLAMPS.

1-78. Harness supports, clamps, and spacers whose locations are shown in R-3825-4 must be installed at those locations. If exact clamp locations are not shown in R-3825-4, clamps must be positioned so that distances between clamps do not exceed 16 inches. Clamps must be installed sufficiently tight to prevent harness movement within the clamp but not so tight as to damage the harness. Clamps up to 3 sizes larger or smaller than the sizes specified in R-3825-4 at a particular location may be used as necessary to install the harness in accordance with these requirements. The clearance requirements listed in this paragraph are applicable to harnesses in the installed position with no external load applied. Clamps and harnesses may be repositioned to achieve compliance with the clearance requirements. Clamps and supports must be positioned to provide maximum separation between the harness and adjacent surfaces, but where it is unavoidable, harnesses may contact other harnesses and any surfaces except those listed in steps a through c.

a. Harnesses must be separated by at least 1/8 inch from tubing that is less than 2.00 inches OD.

b. Harnesses must not directly contact components or lines that contain or flow hot-gas products except for normal connections of harness electrical connectors to components installed in hot-gas systems. Indirect contact is acceptable, however, such as harness contact with a support attached to a hot-gas component.

c. Harnesses must not contact sharp edges (edges with radii that are less than 0.12 inch).

d. If a bonding connection was disconnected and reconnected, use a milliohmmeter and measure bonding resistance from component that is bonded to component or structure to which it is bonded. Resistance must not exceed 100 milliohm.

1-79. INSPECTION AND INSTALLATION REQUIREMENTS AND CRITERIA FOR SUPPORT CLAMPS FOR LINES OF LESS THAN 2.00 INCHES OUTSIDE DIAMETER.

1-80. Lines must be supported by the clamps and line blocks specified in R-3825-4. If exact clamp or support locations are not shown in R-3825-4, clamps or supports must be positioned to provide the following maximum distances between clamps or supports, as applicable for the line (tubing) size:

Line Size in Inches OD	Maximum Distance in Inches Between Clamps or Supports
1/4, 5/16, and 3/8	18
1/2, 5/8, and 3/4	25-1/2
1 or larger	30

Clamps and supports must be positioned to provide 1/8-inch minimum separation between lines and adjacent surfaces unless otherwise specified in steps a through f.

a. Contact is permitted between lines and the following engine components and surfaces:

(1) Thermal insulation (including electrical harness boots)

(2) Oxidizer and fuel turbopumps if lines are installed as part of turbopumps

(3) Customer connect lines support 106642 (applicable only to fluid interface lines)

b. Contact is permitted between flexible sections of fluid interface lines located between the customer connect lines support 106642 and the customer-connect fluid interface panel.

c. Between stage static instrumentation line CG1a and the main oxidizer valve housing, minimum allowable clearance is 0.060 inch.

d. Between the fuel bleed line and the start tank gaseous refill line, minimum allowable clearance is 0.030 inch.

e. Between the augmented spark igniter propellant lines and the main injector, the minimum allowable clearance is 0.030 inch. However, clearances of instrumentation pickups attached to the propellant lines are not restricted; instrumentation pickups are permitted to contact other surfaces.

f. Contact is permitted between the fuel bleed line and helium heat exchanger line from either side of the engine-mounted fluid line interface support bracket to the first bend in the helium heat exchanger line (SIVB stage only).

1-81. PRESSURIZING AND PURGING AGENT REQUIREMENTS.

1-82. Agents used for pressurizing or purging engine systems and components must meet the requirements of paragraphs 1-83 and 1-84.

1-83. HELIUM. When helium is specified in this manual (Volumes I and II), the following requirements must be met:

a. Helium must conform to Bureau of Mines, Grade A.

b. Helium must have a water content less than that defined by a dewpoint of minus 80° F at standard atmosphere pressure.

c. Helium must be supplied from a system equipped with a 10-micron nominal, 50-micron-absolute filter.

1-84. GASEOUS NITROGEN. When gaseous nitrogen is specified in this manual (Volumes I and II), the following requirements must be met:

a. Gaseous nitrogen must conform to MIL-P-27401.

b. Gaseous nitrogen total hydrocarbon content must not exceed 10 ppm.

c. Gaseous nitrogen supply must be equipped with a 10-micron-nominal, 50-micron-absolute, filter.

1-84A. AIR. When air is specified in this manual (Volumes I and II) as an alternate to gaseous nitrogen for engine drying, the air must meet the cleanness level and inspection requirements of MSFC-PROC-404.

1-85. LIQUID NITROGEN. When liquid nitrogen is specified in this manual (Volumes I and II), it must conform to the requirements of MIL-P-27401.

1-86. CLEANING REQUIREMENTS.

1-87. All engine parts and components and tools that are to be installed in or will come in contact with interior surfaces of an engine propellant or pneumatic system must be cleaned, packaged, and certified clean for the applicable engine system in accordance with the requirements of MSFC Specification 164, Specification for Cleanliness of Components for Use in Oxygen, Fuel, and Pneumatic Systems, or as specifically outlined in the following paragraphs. Parts with dyed or inked surfaces, to be oxidizer compatible, must be stripped of dye or ink (paragraph 1-87A) before cleaning. Components or parts removed from an engine for access and handled in accordance with the contamination prevention requirements contained in this manual can be reinstalled on the engine. Paragraphs 1-88 through 1-110 contain procedures for cleaning engine parts and components that are not installed in contact with an engine propellant or pneumatic system; procedures for inspecting, cleaning, and packaging engine protective closures, test plates, or handtools for use on propellant or pneumatic system openings; and procedures for inspecting and packaging engine parts and components to prevent contamination, and for storage and shipment. Cleaning materials for these procedures are specified in figure 1-22.

1-87A. STRIPPING DYED PARTS.

1-87B. This procedure provides instructions for removing dye or ink (if present) from parts that are to be cleaned for oxidizer compatibility. Removal of the dye or ink may require the use of methyl-ethyl-ketone (Federal Specification TT-M-261), isopropyl alcohol (Federal Specification TT-I-735), or acetone (Federal Specification O-A-51) depending on the physical composition of the dye.

a. During this procedure, observe safety precautions in paragraphs 1-2 and 1-7.

WARNING

The following procedure specifies methyl-ethyl-ketone, acetone, or isopropyl alcohol which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

b. Strip dye or ink from part by brushing or wiping surface with a natural-bristle brush or a clean, lint-free cloth dipped in one of the following, in the order listed, until all dye or ink is removed.

(1) Methyl-ethyl-ketone (Federal Specification TT-M-261).

(2) Acetone (Federal Specification O-A-51).

(3) Isopropyl alcohol (Federal Specification TT-I-735).

c. Clean part as outlined in paragraph 1-87.

1-88. CLEANING ELECTRICAL CABLES AND EXTERIOR OF ELECTRICAL CONNECTORS.

1-89. Clean electrical cables and exterior surfaces of electrical connectors as follows:

a. Obtain the following materials:

(1) Methyl-ethyl-ketone (Federal Specification TT-M-261).

(2) Isopropyl alcohol (Federal Specification TT-I-735)

(3) Natural-bristle brush

(4) Gaseous nitrogen (paragraph 1-84)

b. During this procedure, observe safety precautions in paragraphs 1-2 and 1-7.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

c. Remove dirt, dust, moisture, and foreign particles from cables and connectors by blowing with low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84).

Material or Specification Number	Name	Use
MIL-C-81302 or	Cleaning compound	Cleaning engine and component external surfaces and protective closures. Final rinsing and handwiping of ducts, tubing, metal hoses and parts, and nonmetal parts. Handwiping titanium, KEL-F, Mylar, Teflon, and combination of metal and nometal parts.
MSFC-SPEC-237	Cleaning solvent	
MIL-P-27401	Gaseous nitrogen	Purging and drying clean parts.
MIL-T-27602	Trichloroethylene	Cleaning exterior surfaces of engine. Final rinsing of combination of metal and nonmetal parts. Handwiping of KEL-F, Mylar, and Teflon parts.
MIL-T-81533	Trichloroethane	Cleaning exterior surfaces of engine. Final rinsing of combination of metal and nonmetal parts. Handwiping of KEL-F, Mylar, and Teflon parts.
MSFC-PROC-404	Air	Drying clean parts.
O-A-51	Acetone	Cleaning dye or ink from parts.
P-D-680 Type I	Drycleaning solvent	Removing adhesive deposits of labels during cleaning of protective closures.
P-S-311 Type II	Scouring powder	Cleaning external surfaces of engine and components.
TT-I-735	Isopropyl alcohol	Cleaning electrical connectors, protective closures, and stripping dye or ink from surfaces that require oxidizer-compatible materials.
TT-M-261	Methyl-ethyl-ketone	Cleaning electrical wire harness and boots and stripping dye or ink from surfaces that require oxidizer-compatible materials.
	Deionized water (25,000 and 50,000 ohm-centimeters specific resistance)	Rinsing parts during cleaning operations.
Cellosize HECQP-15000 (Union Carbide)	Hydroxethyl-cellulose	Cleaning external surfaces of engine and components.
Oakite No. 61B (Oakite Products, Inc)	Cleaner	Cleaning protective closures.
Turco 4518 (Turco Products)	Cleaner	Cleaning external surfaces of engine and components.
MIL-A-6091	Denatured alcohol	Cleaning protective closures.

Figure 1-22. Cleaning Materials

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

d. Remove stains, grease, and foreign materials from exterior surfaces of cables, including thermal protecting boot, by brushing with a soft-bristle brush or by wiping with a clean, lint-free cloth dampened (not saturated) with methyl-ethyl-ketone solvent (Federal Specification TT-M-261). Do not allow methyl-ethyl-ketone to contact inner surfaces of connectors.

WARNING

The following procedure specifies isopropyl alcohol, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

e. Clean exterior surfaces of connectors by brushing lightly with a soft-bristle brush dipped in isopropyl alcohol (Federal Specification TT-I-735).

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

f. Immediately dry exterior surfaces of connector by blowing surfaces with low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A) for 2 minutes minimum.

1-90. CLEANING INTERIOR OF ELECTRICAL CONNECTORS.

1-91. Clean interior of electrical connectors as follows:

a. Obtain the following materials:

(1) Isopropyl alcohol (Federal Specification TT-I-735)

(2) Soft-bristle brush or cotton swabs

(3) Gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A)

b. During this procedure, observe safety precautions in paragraphs 1-2 and 1-7.

c. If insulators are installed on the male connector pins, remove and discard insulators, using No. 10, 11, or 12 crochet needle (one in tool kit 9024994).

WARNING

The following procedure specifies isopropyl alcohol, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

d. Clean interior surfaces of connectors by brushing lightly with a cotton swab or a soft-bristle brush dipped in isopropyl alcohol (Federal Specification TT-I-735).

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

e. Immediately dry connector by blowing connector with low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A) for 2 minutes minimum.

f. Install protective closure on connector unless connector is to be connected immediately.

1-91A. CLEANING TARNISH FROM ELECTRICAL CONNECTOR PINS.

WARNING

The following procedure specifies isopropyl alcohol which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

- The following procedure specifies phosphoric acid, which is a toxic and corrosive liquid. Inhalation of its vapors or contact with the liquid can cause serious injury. Eye protection and protective clothing must be worn by personnel handling phosphoric acid.

- The following procedure specifies thiourea, which is toxic and poisonous. Inhalation of its vapors or prolonged contact with or ingestion of the material can cause serious injury or death.

a. Prepare a cleaning solution of the following ingredients:

Ingredient	Percent by Weight
Phosphoric Acid (85%) (Federal Specification O-O-670)	6
Isopropyl Alcohol (Federal Specification TT-I-735)	6
Thiourea (J.T. Baker Chemical Co)	15
Deionized or distilled water	73

b. Using a clean cotton swab moistened in cleaning solution prepared in step a, lightly burnish pin until tarnish is removed. Do not burnish pin to the extent that pin plating is damaged or base metal is exposed.

c. Using a clean cotton swab, moistened in deionized or distilled water, remove residual cleaning solution from cleaned pin.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

d. Using a clean cotton swab moistened in isopropyl alcohol (Federal Specification TT-I-735) remove residual water from electrical connector; then thoroughly dry electrical connector by blowing with low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401) for 2 minutes minimum.

1-92. CLEANING EXTERIOR SURFACES OF ENGINE AND COMPONENTS.

1-93. This procedure provides instructions for removing superficial deposits from engine and component surfaces. Two cleaning methods are acceptable. Use the liquid cleaning compound method outlined in steps a, b, c, and d on surfaces where running or dripping does not occur. Use the paste cleaning compound method outlined in steps a, b, c, and e where increased retention of compound is required and running and dripping must be avoided.

a. Obtain the following tools and materials:

(1) Acid-resistant-bristle brush

(2) Clean, lint-free cloths

(3) Clean paper towels

(4) Cotton swabs

(5) Cellosize HEC QP-15000 (hydroxethylcellulose) (Union Carbide)

(6) Deionized or distilled water

(7) Neoprene gloves

(8) Forty-eight inch-wide polyethylene plastic masking

(9) Two-inch-wide roll of masking tape

(10) Sponge

(11) Trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302), or cleaning solvent (MSFC-SPEC-237)

(12) Turco 4518 (Turco Products)

b. During this procedure, observe safety precautions in paragraphs 1-2 and 1-7.

WARNING

The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquid can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302) or cleaning solvent (MSFC-SPEC-237), which is volatile. Use in a well-ventilated area since the vapors displace oxygen in the air, resulting in suffocation.

c. Remove any grease or oil from surface to be cleaned by wiping with clean cloths or paper towels dampened with trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302) or cleaning solvent (MSFC-SPEC-237).

WARNING

Eye protection and protective clothing must be worn to prevent liquid cleaning compound from contacting any part of the body.

d. Perform liquid cleaning compound method as follows:

(1) Wear neoprene gloves.

(2) Thoroughly mix 16 ±0.1 ounces of Turco 4518 (Turco Products) and one gallon of deionized or distilled water until ingredients are completely dissolved. (Proportionate quantities may be prepared. Solution has no shelf life limitation.)

(3) Using plastic sheet and masking tape, protect any electrical wiring, nonmetal surfaces, and components not being cleaned.

CAUTION

Extreme care must be taken during cleaning procedures to prevent the solution from entering open ports of components.

- The solution must not be applied in sun-exposed or to heated surfaces, because the solution will dry and be difficult to remove.

(4) Clean surface by rubbing with clean cloth, acid-resistant-bristle brush, or cotton swab dampened with solution. Allow solution to remain on surface at least 2 minutes, replenishing solution several times.

(5) Remove bulk of solution from surface by wiping with clean, dry cloths or paper towels.

(6) Wipe surface with clean cloths or paper towels dampened with distilled or deionized water until residue is removed. The solution is not harmful to external surfaces of the engine or components; however, it will leave a white residue if not removed.

(7) Using distilled or deionized water in a squeeze bottle, rinse cleaned surface sparingly. Use sponge to absorb excess water.

(8) Repeat substeps 4 through 7 as necessary.

(9) Dry surface with clean, dry cloths or paper towels.

WARNING

Eye protection and protective clothing must be worn to prevent paste cleaning compound from contacting any part of the body.

e. Perform paste cleaning compound method as follows:

(1) Wear neoprene gloves.

NOTE

Materials must be at ambient temperature when Cellosize is added.

(2) Thoroughly mix one gallon of liquid cleaning solution prepared as outlined in step d, substep 2, with 2.55 ±0.15 ounces (1.7 ±0.1 percent by weight) of Cellosize HEC QP-15000 (Union Carbide) until solution thickens to a syrupy consistency. (Proportionate quantities may be prepared. Shelf life of mixture is 6 days maximum.)

CAUTION

Compound must not be applied in sunshine or to heated surfaces, because compound will dry and be difficult to remove.

(3) Clean surface by applying a thin coat of paste cleaning compound and rubbing with a clean cloth or acid-resistant-bristle brush.

(4) Allow paste cleaning compound to remain on surface for 2-10 minutes.

(5) Remove paste cleaning compound by wiping surface with clean cloths or paper towels dampened with deionized or distilled water. Continue until residue is removed. The compound is not harmful to external surfaces of engine or components; however, it will leave a white residue if not removed.

(6) Repeat substeps 3 through 5 as necessary.

(7) Dry surface with clean, dry cloths or paper towels.

1-94. CLEANING EXTERIOR SURFACES TO REMOVE TENACIOUS RESIDUES.

1-95. The following procedure, for removal of baked-on or tenacious residues from hot sections of the engine after firing, is to be used only after all efforts to remove residues by normal cleaning methods have failed.

a. Remove residue by use of cleaning compound (MIL-C-81302) or cleaning solvent (MSFC-SPEC-237), trichloroethane (MIL-T-81533), or trichloroethylene (MIL-T-27602) and by use of liquid or paste Turco 4518 (Turco Products) in accordance with paragraph 1-92.

b. Obtain the following materials:

(1) Scouring powder, Type II (Federal Specification P-S-311)

(2) Deionized or distilled water

(3) Clean, lint-free cloth

(4) Clean paper towels

(5) Polyethylene plastic sheet, 48 inches wide

(6) Two-inch-wide roll of masking tape

c. During this procedure, observe safety precautions in paragraphs 1-2 and 1-7.

d. Using plastic sheet and masking tape, protect any electrical wiring, nonmetal surfaces, and components not being cleaned.

CAUTION

The following procedure specifies scouring powder, which is an abrasive and must be used with extreme care to avoid excessive removal of the base material being cleaned.

e. Using a small amount of scouring powder, Type II (Federal Specification P-S-311), on a clean, water-dampened cloth, gently rub area covered by residue. Exercise care to confine use of scouring powder to immediate area covered by residue, and avoid abrading surrounding area.

f. Remove scouring powder and residue by wiping surface with clean cloths or paper towels dampened with deionized or distilled water.

g. Repeat steps e and f until residue is completely removed.

h. Dry surface with clean, dry cloths or paper towels.

i. Remove masking tape and protective plastic sheet.

1-95A. CLEANING EXTERIOR SURFACES TO REMOVE MINOR RUST.

1-95B. This procedure should be used only after normal cleaning methods have failed and then only to remove minor rust and residue or a deposit resembling rust.

a. Obtain the following materials:

(1) Bear - Tex #85-1 silicon carbide pad (Norton Co)

(2) Clean, lint-free cloth

(3) Clean paper towels

(4) Deionized or distilled water

(5) Nitric Acid (Federal Specification O-N-350)

CAUTION

This procedure requires use of silicon carbide, which is an abrasive and must be used with care to avoid excessive removal of the base material being cleaned.

b. Using a dry pad of Bear - Tex #85-1, gently rub rust deposit. Confine use of pad to immediate area covered by deposit, and avoid abrading surrounding area.

c. Wipe area with lint-free cloth or clean paper towels dampened with deionized or distilled water.

d. Dry surface with clean, dry cloths or paper towels.

e. Repeat steps b, c, and d until all signs of the deposit are removed.

f. Repassivate 300- and 400-series corrosion-resistant steel as follows: (Parts brazed with silver, copper, or nickel alloys must not be passivated. Do not passivate the following alloys: Hastelloy B, 440 A (annealed), Monel 440, 440 B (annealed), Monel K-500, 440 C (annealed), nickel 200, 440 F (annealed) or nickel 201.)

WARNING

The following procedure specifies nitric acid. Contact with nitric acid solution can cause serious injury to personnel or damage to equipment.

(1) Prepare a 40-50 percent, by volume, solution of nitric acid (Federal Specification O-N-350). Slowly pour acid into required amount of distilled or deionized water.

(2) Using a cotton swab, passivate area by swabbing with nitric acid solution at 10-minute intervals for a minimum of 60 minutes. If necessary, provide a barrier to prevent solution from dripping on other equipment.

(3) Thoroughly rinse cotton swab and area with tap water.

(4) Final-rinse area with deionized or distilled water.

(5) Dry area with clean, dry cloth.

1-96. CLEANING PROTECTIVE CLOSURES, TEST PLATES, AND HANDTOOLS.

1-97. The procedures for cleaning protective closures, test plates, and handtools are handwiping and/or handbrushing and immersion cleaning. These procedures may be used at the maintenance site instead of returning the items to the cleaning facility if the inspection methods used (paragraph 1-98) are valid.

1-98. INSPECTING PROTECTIVE CLOSURES, TEST PLATES, AND HANDTOOLS FOR CLEANNESS. Inspect protective closures, test plates, and handtools before cleaning to determine whether items require cleaning, or after cleaning to determine clean condition, by visual inspection (paragraph 1-104) and by soiling test (paragraph 1-106). The inspection methods are valid only if all surfaces are visible and accessible.

1-99. CLEANING PROTECTIVE CLOSURES, TEST PLATES, AND HANDTOOLS BY HANDWIPING AND/OR HANDBRUSHING. This procedure is limited to those protective closures so constructed that all engine-contacting surfaces are exposed for cleaning and to those test plates and handtools so constructed that all surfaces will be contacted by handwiping and/or handbrushing.

a. The following tools and materials will be used when applicable:

(1) Rubber stopper

(2) Drycleaning solvent (Federal Specification P-D-680)

(3) Nu-Wipe paper tissue toweling (Lacquerwax Co), or equivalent

(4) Nylon cloth No. 7815 (Victor Gloves, Inc), or equivalent

(5) Nylon-bristle brush

(6) Polyethylene gloves (Plastic Smith), or equivalent

(7) Gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A)

(8) Cleaning compound (MIL-C-81302), cleaning solvent (MSFC-SPEC-237), isopropyl alcohol (Federal Specification TT-I-735), or denatured alcohol (MIL-A-6091)

b. During this procedure, observe safety precautions in paragraphs 1-2 and 1-7.

c. Protect any humidity indicators that cannot be removed from protective closures, by sealing exposed indicating surface with clean rubber stopper.

CAUTION

Rubber or neoprene gloves must not be worn, since cleaning solvents dissolve these materials and leave a contaminated residue on the surface of the closure.

d. Wear polyethylene gloves during cleaning operations.

e. Peel any tamperproof label from protective closures, test plates, or handtools to be cleaned.

WARNING

The following procedure specifies drycleaning solvent, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

f. Remove any adhesive deposits, left by removal of tamperproof labels, that adhere to surface of protective closures, test plates, or handtools by wiping lightly with Nu-Wipe paper tissue toweling (Lacquerwax Co) dampened with drycleaning solvent (Federal Specification P-D-680).

g. Immediately dry the wetted surface with a clean, dry nylon cloth.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302) or cleaning solvent (MSFC-SPEC-237), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

- The following procedure specifies denatured alcohol, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.
- The following procedure specifies isopropyl alcohol, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

h. Clean protective closure, test plate, or handtool by handwiping with clean nylon cloth or scrubbing with a clean nylon-bristle brush wetted in cleaning compound (MIL-C-81302), cleaning solvent (MSFC-SPEC-237), isopropyl alcohol (Federal Specification TT-I-735), or denatured alcohol (MIL-A-6091).

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

i. Dry protective closures, test plates, or handtools by blowing with low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A) until all cleaning solvent has evaporated. Use extreme care to dry crevices and area where cleaning solution could be trapped. Protective closures, test plates, or handtools may be dried by an alternate method (only when gaseous nitrogen drying is not possible) by handwiping with clean, lint-free, dry nylon cloth until surfaces are visibly dry. Do not rub critical plastic surfaces with a dry cloth or tissue during a final drying operation since this causes an electrostatic charge to build up. The electrostatic charge will attract dust particles to the plastic surface.

j. Inspect protective closures, test plates, or handtools for cleanness by visual inspection (paragraph 1-104) and by soiling test (paragraph 1-106).

k. Handle and package cleaned protective closures in accordance with paragraph 1-101.

l. Use, or package (paragraph 1-108) test plate or handtool.

1-100. CLEANING PROTECTIVE CLOSURES, TEST PLATES, AND HANDTOOLS BY IMMERSION. Do not immersion-clean adhesive bonded protective closures, bonded test plates, or test plates with burst diaphragms installed. All metal and nonbonded protective closures and test plates (without burst diaphragms) may be immersion cleaned as follows:

a. The following tools and materials are used when applicable:

(1) Rubber stopper

(2) Drycleaning solvent (Federal Specification P-D-680)

(3) Nu-Wipe paper tissue toweling (Lacquerwax Co), or equivalent

(4) Nylon cloth No. 7815 (Victor Gloves, Inc), or equivalent

(5) Gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A)

(6) Oakite No. 61B (Oakite Products, Inc)

(7) Deionized water

b. During this procedure, observe safety precautions in paragraphs 1-2 and 1-7.

c. Protect any humidity indicators that cannot be removed from protective closures, by sealing exposed indicating surface with a clean rubber stopper.

d. Peel any tamperproof label from protective closure, test plate, or handtool to be cleaned.

WARNING

The following procedure specifies drycleaning solvent, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

e. Remove any adhesive deposits left by removal of tamperproof labels, that adhere to

surface of protective closures, test plate, or handtool by wiping lightly with Nu-Wipe paper tissue toweling (Lacquerwax Co) dampened with drycleaning solvent (Federal Specification P-D-680).

f. Immediately dry the wetted surface with a clean, dry nylon cloth.

g. Prepare a solution of 7-8 ounces of Oakite No. 61B (Oakite Products, Inc) per gallon of water and heat to 120° to 160° F.

h. Immerse protective closure, test plate, or handtool in solution. Do not allow protective closure to remain immersed in solution over 10 minutes.

i. Immersion-rinse protective closure, test plate, or handtool in deionized water heated to 130° to 160° F.

j. Spray-rinse protective closure, test plate, or handtool with deionized water. Use extreme care to thoroughly rinse crevices and areas where cleaning solution could be trapped.

WARNING

> Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

k. Immediately after spray rinsing, thoroughly dry protective closure, test plate, or handtool by blowing with low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A) until all rinse water has evaporated. Use extreme care to dry crevices and areas where rinse water could be trapped. Protective closures, test plates, or handtools may be dried by an alternate method (only when gaseous nitrogen drying is not possible) by handwiping with clean, lint-free, dry nylon cloth until surfaces are visibly dry. Do not rub critical plastic surfaces with a dry cloth or tissue during a final drying operation since this causes an electrostatic charge to build up. The electrostatic charge will attract dust particles to the plastic surface.

l. Inspect protective closures, test plates, or handtools for cleanness by visual inspection (paragraph 1-104) and by soiling test (paragraph 1-106).

m. Handle and package cleaned protective closures in accordance with paragraph 1-101.

n. Use, or package (paragraph 1-108) test plate or handtool.

1-101. PACKAGING CLEAN PROTECTIVE CLOSURES. Protective closures are to be packaged individually in clean polyethylene or vinyl bags and certification of cleanness indicated on the exterior of the package.

a. Handle clean protective closures with clean nylon or polyethylene gloves.

NOTE

> Bags may be combined one within another to make up the required thickness.

b. Package nonmetal protective closures in the following minimum-thickness bags:

(1) Six-inch-maximum-diameter protective closures, without indicators, in 0.0015-inch bags

(2) Twelve-inch-maximum-diameter protective closures, with or without indicators, in 0.004-inch bags

(3) Forty-eight-inch-maximum-diameter protective closures, with or without indicators, in 0.006-inch bags

c. Package metal protective closures in the following minimum thickness bags:

(1) Six-inch-minimum diameter or 3 pounds maximum in 0.004-inch bags

(2) Ten-pound maximum protective closures in 0.006-inch bags

d. Seal package, and certify protective closure cleanness on exterior of package.

1-102. <u>INSPECTING PARTS FOR USE IN PROPELLANT AND PNEUMATIC SYSTEMS.</u>

1-103. Several test methods are used to determine whether cleaned parts or parts removed from an engine meet the requirements for propellant and pneumatic service. Since no single test is conclusive, it is recommended that more than one test be performed if any doubt exists as to the cleanness of the parts.

1-104. VISUAL INSPECTION FOR CLEANNESS. Inspect parts for moisture, rust, scale, dirt, chips, oil, grease, or other foreign materials that require recleaning of parts. Discoloration caused by welding or passivation is not considered grounds for recleaning unless accompanied by rust or scale.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

1-105. WATER-BREAK TEST. This test is performed on metal parts by pouring a small amount of distilled water over visible and completely accessible cleaned areas of the part. An unbroken water film must form on the metal surface. If the water forms into small droplets, reclean the part. Following testing, the water may be removed with a clean, lint-free cloth or dried with low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84). Some materials, even if clean, do not form an unbroken water film and require additional tests.

1-106. SOILING TEST. Lightly wipe cleaned parts with a clean, lint-free white nylon cloth No. 7815 (Victor Gloves, Inc), or equivalent. Any visible deposit on the cloth requires recleaning of the part. (If excess pressure is applied when wiping soft metals, such as aluminum, metal removal can occur and be confused with dirt.)

1-107. PACKAGING PARTS OR COMPONENTS FOR USE IN PROPELLANT AND PNEUMATIC SYSTEMS.

1-108. Parts or components that come in contact, either directly or indirectly, with the propellants or pneumatic gases must be packaged after cleaning or verification of cleanness, to prevent contamination.

a. Wear clean nylon or polyethylene gloves when handling parts or components where hand contact is made with sealing surfaces or surfaces that contact operating fluid (liquid or gas).

b. Package parts or components immediately after being cleaned and cooled to ambient temperature, except when parts are to be assembled.

c. Package small, lightweight parts that have external or exposed surfaces and come in contact with operating fluid, in a clean vinyl or polyethylene (0.004-inch minimum) bag, and heat-seal bag. If part weighs more than 3 pounds, use bags with a minimum wall thickness of 0.006 inch.

d. When packaging parts with sharp projections, use 2 bags, one inside the other, to minimize possibility of puncture. If this method is inadequate, use an initial wrap of several layers of polyethylene film instead of inner bag.

e. For parts with such configuration, fragility, finish, or weight that packaging instructions in steps d and e are inadequate, wrap parts in polyurethane or polyethylene foam. For parts weighing less than 7 pounds, the minimum thickness of the polyurethane foam must be 1/2 inch, and for parts weighing 7-10 pounds, one inch. If polyethylene foam is used, the minimum thickness used must be 1/8 inch for parts less than 7 pounds, 1/4 inch for parts weighing 7-10 pounds, 3/8 inch for parts weighing 10-15 pounds, and 1/2 inch for parts weighing 15-20 pounds. Parts must then be packed in a suitable, snug-fitting container marked with the same information as on the part except the serial number.

f. Certify cleanness; identify all parts as to specific service with appropriate seals, labels, or decals. Seals, labels, or decals must not be applied to surfaces that will be in contact with the propellants or pneumatic gases, machined surfaces, or sealing surfaces.

g. Seal decals or labels to plastic bag during sealing operation.

h. Identify parts that have been lubricated for a specific service with appropriate labels or decals.

i. For parts packaged in cartons, certify that part has been cleaned and properly packaged by marking specific service on exterior of package.

1-109. COMPONENT SHIPPING AND STORAGE REQUIREMENTS.

1-110. Components and parts must meet the following requirements prior to packing for storage or shipping to maintain component or part cleanness level.

a. All protective closures, caps, and plugs must be properly installed on the component or part, and the level of cleanness and service must be indicated on each closure.

b. The bags in which components or parts are packaged must be sealed; the level of cleanness and service must be indicated on the exterior of the package as outlined in paragraph 1-107.

c. The component or part must be packaged using the Rocketdyne Automated Packaging System.

1-111. AGE-CONTROLLED COMPOUNDS.

1-112. The shelf-life requirements of a compound provides the warranty limits of the compound; not the useful life limits. A compound can exceed its maximum usable life before its shelf-life expiration date if the aging process of the compound has somehow been accelerated. Conversely, often compounds under proper storage conditions can be used over a much longer period than their shelf life limits indicate.

1-113. TESTING COMPOUNDS FOR USABILITY.

1-114. Simple and inexpensive tests have been devised to determine the usability of age-controlled compounds in the field. These tests are designed to be used when it is imperative to use a compound without delay when recertification cannot be immediately confirmed. There is no limit to the number of times a material may be tested to determine its usability, unless stated otherwise. Accepting a compound for use under the usability test criteria does not, however, recertify the compound to the original specification standards. Recertification of certain compounds, as deemed necessary by the local Quality Representative, must be returned to Rocketdyne for analysis and recertification.

1-115. USABILITY OF COMPOUNDS.

1-116. Shelf life of a compound is normally specified for a period of time (6 months, 12 months, etc) that starts from the date the compound was manufactured. If in the judgment of the local Quality Representative the tested compounds exhibit favorable properties, as described in the usability tests, the compound should be considered to be usable and the shelf life extended to one-half the original shelf life, unless stated otherwise. For example: if the original shelf life was 12 months, the shelf life can be extended an additional six months. Subsequent successful tests also extend the shelf life six months (one-half the original shelf life). After a compound has passed the usability test, the Quality Representative fills out a Serviceable Label-Material tag, DD Form 1574, with the required data and attaches it to the compound container. The completed tag, which includes the new shelf life extended time period, serves as the official age control document.

1-117. STORAGE ENVIRONMENT AND CONTAINER CONDITION.

1-118. The storage area and the condition of the compound containers should be examined before agitating or opening the container to determine if the immediate environment has a possible effect on the usability of the compound.

1-119. STORAGE ENVIRONMENT. Proper storage is imperative. For example, the aging of many compounds may be minimized by storing the compound in a $<32°$ F environment. However, literature accompanying the compound may warn against such storage and it must be determined what storage conditions are recommended for each compound, and whether the compounds meet these conditions. Usually, storage in direct sunlight, in areas of high heat, or in an area of fluctuating temperature will cause detrimental effects on a compound's usability.

1-120. CONDITION OF CONTAINER. Containers should be kept tightly closed. Loss of volatile constituents or absorption of moisture due to incorrectly closed or sealed containers will generally accelerate or inhibit cure properties, decreasing the maximum usable life of the compound. Use caution with questionable containers.

1-121. CONDITION OF COMPOUND.

1-122. Before agitating or stirring the contents of a container, open the container and determine the general condition of the compound. Following are a few typical examples of what can be encountered during inspection of the general condition of compounds. The user must determine which properties may or may not affect the useful life of a compound:

a. Skinning. Some liquid develop a partially cured skin or thin crystallized shell over the exposed top portion of the liquid in the container. Sometimes, removing this skin will expose usable material; other times this skin is cause for disposing of the compound. Where literature or usability criteria allow formation of surface skinning, it must be removed before stirring or agitating the container, as follows:

(1) Using a spatula, carefully free edge of skin from side of container.

(2) Carefully lift skin out of container in as large of piece as possible.

(3) Remove as many remaining small pieces as possible.

b. Wet Caking. Fillers in certain compounds are evenly dispersed during the manufacturing process and upon storage settle to form a thick mass at the bottom of the container. The following steps should be followed to determine whether the material is usable when caking exists. If literature notes that caking or settling is a cause for disposal, discard material.

(1) Lower a spatula to bottom of container and note viscosity of material in upper half of container. Any caking will show up as increased viscosity when spatula is stirred at bottom of container and compared to viscosity of material in upper half of container. Remove spatula and inspect it for evidence of caking.

(2) If caking in container is hard and cannot be stirred or penetrated with spatula, the material has exceeded its maximum usability life.

(3) If caking is firm, but can be stirred, remix caking with liquid media (supernate) as outlined in substeps 4 through 8.

(4) Pour supernate into suitable clean container, to expose caking in original container.

(5) Stir and break up caking as much as possible and pour back a small amount of supernate into original container.

(6) Try to form a homogeneous paste by mixing small amount of supernate with caking.

(7) Pour another small amount of supernate into original container and again form a homogeneous paste. Continue this operation until all supernate has been added back as completely as possible and a homogeneous mixture is formed.

(8) If a homogeneous mixture containing few gelled bodies, few undispersed conglomerates, or few coarse particles cannot be formed, dispose of material.

c. Dry Caking. Some fillers may be shipped separately or in the dry state and are to be mixed with the compound when it is ready for use. Dry caking of the filler can be determined as follows:

(1) Remove a small amount of filler from container to be examined and note condition of sample as to uniformity, particle size, and apparent moisture content.

(2) If filler has not absorbed much moisture, break lumps into fairly uniform size with blunt instrument or mortar and pestle.

(3) If filler has absorbed moisture, moisture can be safely removed from most fillers by placing filler in dessicator or vacuum drying filler at approximately 75° F for 24 hours.

(4) If caking cannot be reduced to a usable material, discard filler.

d. Gelling. Ordinarily, materials that gel are pourable rubber-based materials that gradually change in properties over an extended period of time. Determine if material has gelled as follows:

(1) Lower a spatula into material and observe its qualities to determine if it is abnormally thick or gellatinous.

(2) If material has not fully gelled, gelled particles may be noted by inserting and removing spatula and allowing a stream of material to flow from it. If gelling is detected, discard material, since it will generally be a short time before the maximum usability time is exceeded.

e. Separation. Two or more liquids in a homogeneous system may separate upon standing (similar to caking). Depending on the material, separation may or may not be cause for disposal. If separation has occurred, try to reblend material by careful stirring or mechanical agitation. If a homogeneous blend cannot be obtained, dispose of material.

f. Solidification. Some liquid materials will eventually cure, crystallize, or solidify in their containers over an extended period as evidenced by the presence of a hard solid mass. The material can generally be considered useless if found in this condition.

g. Contamination. Contamination or adulteration of a frequently used material can easily occur and can be recognized by discoloration, dirt, or partial cure. Simple contamination can be prevented as follows:

(1) Keep containers tightly closed.

(2) Keep pouring spouts and openings clean.

(3) Take samplings with clean utensils.

(4) Do not pour unused material back into original container.

1-123. PREWEIGHED COMPOUNDS.

1-124. Components of some compounds (generally in kit form) are preweighed for convenience and are to be mixed and used for one application. Test samples of these preweighed compounds can be made if the following conditions exist:

a. Mixing ratios are known.

b. Enough of the component exists for accurate weighing.

c. Care is taken not to leave containers open longer than necessary.

d. Material loss is minimized.

Any container that cannot be resealed, should be placed in a container that is sealable. If the above steps cannot be met or when a kit is small enough to be expendable, use the whole kit rather than trying to reseal containers.

1-125. A-4000 ADHESIVE AND CATALYST (DOW CORNING CORP).

1-126. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Description. Two-part silicone adhesive.

c. Type Container. Adhesive base, can; catalyst, vial.

d. Color. Adhesive base, clear; catalyst, clear.

e. Consistency. Adhesive base, thin pourable; catalyst, thin pourable.

1-127. USABILITY TEST.

WARNING

Adhesive and catalyst A-4000 is flammable and must not be used near heat, sparks, or open flame. Its catalyst may irritate the skin. In case of contact, wash skin with soap and water.

a. Test I.

(1) Remove lids and check each component. Each component must be free of skin, lumps, and coagulation.

(2) Mix appropriate amounts of components together. Both components must be capable of being mixed together to form a smooth, uniform compound.

b. Test II.

(1) If components are not rejected in Test I, thoroughly condition enough of both components at 77° ±5° F for a 25-30 gram sample.

(2) Mix the appropriate amount of curing agent with sample of base compound.

(3) Allow mixture to cure at 77° ±5° F for 8 hours.

(4) If catalyzed compound cannot be easily mixed after curing, both components are usable.

(5) If catalyzed compound can be easily mixed, either the curing agent or the base material has exceeded its usability life, and each component must be discarded.

1-128. A-4014 OR A-4094 PRIMER (DOW CORNING CORP).

1-129. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. Primer for A-4000 adhesive.

c. Type Container. Can.

d. Color. Light straw.

e. Consistency. Thin pourable.

1-130. USABILITY TEST.

WARNING

Primer A-4014 or A-4094 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Without shaking original container, pour a small amount of primer into a clear, clean inspection container.

b. Visually examine container with unaided eye. A cloudy appearance or noticeable particles suspended in the liquid is cause for rejecting the primer.

c. If it can be determined that lack of good adhesion of the A-4000 can be attributed to the A-4014 primer, although it has passed the above criteria, the primer must be discarded.

1-131. D-4327 COATING (DYNA-THERM CORP.)

1-132. LEADING PARTICULARS.

a. Shelf Life. 2 months.

b. Specification Ref. MB0120-043.

c. Description. Fluorocarbon, cryogenic, elastomeric coating.

d. Type Container. Bottle.

e. Color. Black.

f. Consistency. Thin, pourable.

1-133. USABILITY TEST.

WARNING

Coating D-4327 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the coating can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Usability life of coating has usually been exceeded when there is evidence of considerable coagulation, indicated by a thick, sticky, rubbery-like substance. If any rubbery lumps are noted when the material is stirred, discard entire batch. (Coagulated material can also be detected by attempting to filter the material through a paint strainer.)

b. If a thin coating applied to a test panel does not dry in 30 minutes or less, discard coating.

1-134. EC1300 ADHESIVE (MINNESOTA MINING AND MFG).

1-135. LEADING PARTICULARS.

a. Shelf Life. 5 months.

b. Description. One-part adhesive.

c. Type Container. Can.

d. Color. Yellow.

e. Consistency. Thin syrup.

1-136. USABILITY TEST.

WARNING

Adhesive EC1300 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the adhesive can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Test I.

(1) Remove lid and check adhesive. Adhesive must be free of skins, lumps, and coagulations.

(2) Apply adhesive to a smooth surface. Adhesive must flow in a thin, even coat.

b. Test II.

(1) If adhesive is not rejected in Test I, apply a thin, even coat of adhesive to sample surfaces to be bonded together. (The samples should be of materials recommended to be bonded by this adhesive and be flat and smooth.)

(2) Allow adhesive to dry to an aggressively tacky stage (evidenced by adhering but not transferring to the finger when touched); then join surfaces and roll or press firmly to ensure contact.

(3) If an aggressively tacky stage cannot be attained or if an effective bond cannot be achieved from two samples joined together, the adhesive has exceeded its maximum usability life and must be discarded.

1-137. EC1357 ADHESIVE (MINNESOTA MINING AND MFG).

1-138. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Description. One-part adhesive.

c. Type Container. Can.

d. Color. Gray-green.

e. Consistency. Thin syrup.

1-139. USABILITY TEST.

WARNING

Adhesive EC1357 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the adhesive can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Test I.

(1) Remove lid and check adhesive. Adhesive must be free of skins, lumps, and coagulations.

(2) Apply adhesive to a smooth surface. Adhesive must flow in a thin, even coat.

b. Test II.

(1) If adhesive is not rejected in Test I, apply a thin, even coat of adhesive to sample surfaces to be bonded together. (The samples should be of materials recommended to be bonded by this adhesive and be flat and smooth.)

(2) Allow adhesive to dry to an agressively tacky stage (evidenced by adhering but not transferring to the finger when touched); then join surfaces and roll or press firmly to ensure contact.

(3) If an aggressively tacky stage cannot be attained or if an effective bond cannot be achieved from two samples joined together, the adhesive has exceeded its maximum usability life and must be discarded.

1-140. EC776 ADHESIVE (MINNESOTA MINING AND MFG).

1-141. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Description. One-part adhesive.

c. Type Container. Can

d. Color. Transparent amber.

e. Consistency. Thin syrup.

1-142. USABILITY TEST.

WARNING

Adhesive EC776 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the adhesive can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Test I.

(1) Remove lid and check adhesive. Adhesive must be free of skins, lumps, and coagulations.

(2) Apply adhesive to a smooth surface. Adhesive must flow in a thin, even coat.

b. Test II.

(1) If adhesive is not rejected in Test I, apply a thin, even coat of adhesive to sample surfaces to be bonded together. (The samples should be of materials recommended to be bonded by this adhesive and be flat and smooth.)

(2) Allow adhesive to dry to an aggressively tacky stage (evidenced by adhering but not transferring to the finger when touched); then join surfaces and roll or press firmly to ensure contact.

(3) If an agressively tacky stage cannot be attained or if an effective bond cannot be achieved from two samples joined together, the adhesive has exceeded its maximum usability life and must be discarded.

1-143. EPON 828 (SHELL CHEMICAL CO).

1-144. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. Epoxy resin.

c. Type Container. Can.

d. Color. Light amber.

e. Consistency. Thick, pourable.

1-145. USABILITY TEST.

WARNING

Epoxy resin Epon 828 may irritate skin. Protective clothing must be worn when handling resin. In case of contact, wash skin with soap and water.

a. Test I.

(1) Remove lid and pour out a sample of resin into a smaller container.

(2) Visually inspect sample. Sample must be free of lumps, crystallization, or coagulation. If sample is not a smooth, uniform, pourable liquid, discard resin.

b. Test II.

(1) If resin is not rejected in Test I, mix 120 grams of resin with a curing agent, eg, 50 grams Versamid 125, known to have previously exhibited cure properties.

(2) If Versamid 125 curing agent is used, allow mixture to stand 6 hours at 77° ±5° F. (Consult literature or contact Rocketdyne Materials and Processes for correct formulations and cure times when other curing agents are used.)

(3) Try to stir mixture after it has set for 6 hours.

(4) If there is difficulty in stirring or if mixture cannot be stirred, the resin is usable.

(5) If it can be easily stirred and it can be demonstrated that the curing agent is not the component inhibiting use, the resin has exceeded its maximum usability life and must be discarded.

1-146. ERL2807 EPOXY HARDENER (UNION CARBIDE).

1-147. LEADING PARTICULARS.

a. Shelf Life. Indefinite.

b. Description. One-part epoxy hardener.

c. Type Container. Can.

d. Color. Black.

e. Consistency. Syrup.

1-148. USABILITY TEST

WARNING

Epoxy hardener ERL2807 is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

a. Test I.

(1) Remove lid and remove any material that has become hardened.

(2) If hardened material cannot be removed, discard hardener.

b. Test II. This test is used only to determine usability of hardener.

(1) Precondition, at 77° ±5°F, epoxy from a batch known to have demonstrated curing ability.

(2) Weigh out a 50-100 gram sample of hardener and precondition at 77° ±5° F.

(3) Add appropriate amount of preconditioned uncured epoxy to preconditioned hardener. Mix thoroughly for one minute.

(4) Allow mixture to set for 2 hours at 77° ±5° F; then attempt to mix it.

(5) If mixture cannot be easily mixed, hardening agent is usable.

(6) If mixture can be easily mixed, hardening agent has exceeded its maximum usability life. Discard each tested container, and additional containers from same lot number stored under same conditions.

1-149. MIL-C-22750, TYPE I, EPOXY POLYAMIDE COATING.

1-150. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. Two-part epoxy-polyamide coating.

c. Type Container. Both components generally in individual can containers.

d. Color. Assorted.

e. Consistency. Epoxy resin, pourable; polyamide resin, thin, pourable.

1-151. USABILITY TEST.

WARNING

Epoxy polyamide coating (MIL-C-22750, Type I,) is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the coating can cause serious bodily harm. In case of prolonged exposure immediately obtain fresh air and wash skin with soap and water.

a. Test I.

(1) Remove lid from component I, which may be either a pigmented epoxy or a pigmented polyamide, depending on the color. Check that component I is capable of being easily mixed to a smooth, homogeneous, pourable liquid, free of pigment flotation, coarse particles, or objectionable settling that cannot be dispersed readily.

(2) Remove lid from component II, which may be either an epoxy or a polyamide, depending on the color of component I. Check that component II is homogeneous, clear, and free of suspended or gelled matter.

(3) If either component does not pass the above steps, discard both components.

b. Test II.

(1) If components pass Test I, mechanically agitate component I for 20 minutes and thoroughly stir component II. Mix one part by volume of component I with one part by volume of component II.

(2) If the components cannot be mixed into a smooth homogeneous compound, discard both components.

(3) Apply MIL-P-23377 primer to a test panel. (See MIL-P-23377 Primer Coating Usability Tests.)

(4) Follow thinning directions, if the paint is generally used as a spray, and apply coatings, as directed, to test panel.

(5) After epoxy-polyamide film dries for correct amount of time, check that it is free from blushing, streaks, blister, coarse particles, or other irregular surface conditions.

(6) If it can be determined that surface irregularities are caused solely by the coating rather than by the application technique or the test panel surface condition, discard both components.

(7) If the coating does not dry to touch in less than 1-1/2 hours, discard both components.

1-152. MIL-P-23377 PRIMER COATING.

1-153. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. Two-part epoxy-polyamide chemical and solvent resistant primer coating.

c. Type Container. Both components generally in individual can containers.

d. Color. Assorted.

e. Consistency. Epoxy resin, pourable; polyamide resin, thin, easily pourable.

1-154. USABILITY TEST.

WARNING

Primer coating (MIL-P-23377) is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the coating can cause serious bodily harm. In case of prolonged exposure, immediately wash skin with soap and water.

a. Test I.

(1) Remove lid from component I, which may be either a pigmented epoxy or a pigmented polyamide, depending on the color. Check that component I is capable of being easily mixed to a smooth, homogeneous, pourable liquid, free of pigment flotation, coarse particles, or objectionable settling that cannot be dispersed readily.

(2) Remove lid from component II, which may be either an epoxy or a polyamide, depending on the color of component I. Check that component II is homogeneous, clear, and free of suspended or gelled matter.

(3) If either component does not pass the above steps, discard both components.

b. Test II.

(1) If components pass Test I, mechanically agitate component I for 20 minutes and thoroughly stir component II. Mix one part by volume of component I with one part by volume of component II.

(2) If the components cannot be mixed into a smooth homogeneous compound, discard both components.

(3) Follow thinning directions if the primer is generally used as a spray, and apply coatings, as directed, to a test panel.

(4) After epoxy-polyamide film dries for correct amount of time, check that it is free from blushing, streaks, blisters, coarse particles or other irregular surface conditions.

(5) If it can be determined that surface irregularities are caused solely by the coating rather than by the application technique or the test panel surface condition, discard both components.

(6) If the primer does not dry hard in less than 7 hours, discard both components.

1-155. MIL-P-8585 PRIMER.

1-156. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. Zinc chromate primer.

c. Type Container. Can.

d. Color. Yellow.

e. Consistency. Syrup.

1-157. USABILITY TEST.

WARNING

Primer (MIL-P-8585) is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Remove lid and check primer for separation of components. Separation of components generally indicates the primer has exceeded its usability life.

b. If separation has occurred, try to reblend mixture by carefully stirring or mechanically agitating the contents.

c. If the primer can be blended into a homogeneous mixture with little evidence of coarse particles dispersed throughout, it has not yet reached its maximum usability life and is usable.

d. If a homogeneous blend cannot be obtained, the primer has exceeded its maximum usability life and must be discarded.

1-158. NUOCURE 28 (TENNECO CHEMICALS).

1-159. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Specification Ref. RB0120-033.

c. Description. Tin octoate curing agent.

d. Type Container. Tube or bottle.

e. Color. Clear.

f. Consistency. Thin, easily pourable.

1-160. USABILITY TEST.

WARNING

Curing agent Nuocure 28 must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling catalyst. In case of contact, flush eyes with water for at least 15 minutes; wash skin with soap and water; and get medical attention.

a. Weigh out a 50-100 gram sample of uncured silicone that has previously demonstrated the ability to be cured. Precondition the uncured silicone and curing agent to 77° ±5° F.

b. Mix appropriate amounts of components together for one minute.

c. Allow mixture to stand for 30 minutes; then try to mix it.

d. If the catalyzed silicone cannot be easily mixed, the curing agent is usable.

e. If the catalyzed silicone can be mixed, the curing agent has exceeded its maximum usability life, and must be discarded.

1-161. PR-1531 PRIMER (PRODUCTS RESEARCH AND CHEMICAL, SEMCO).

1-162. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Description. Primer.

c. Type Container. Can.

d. Color. Gray.

e. Consistency. Syrup.

1-163. USABILITY TEST.

WARNING

Primer PR-153 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Remove lid and check primer for separation of components. Separation of components generally indicates the primer has exceeded its usability life.

b. If separation has occurred, try to reblend mixture by carefully stirring or mechanically agitating the contents.

c. If the primer can be blended into a homogeneous mixture with little evidence of coarse particles dispersed throughout, it has not yet reached its maximum usability life and is usable.

d. If a homogeneous blend cannot be obtained, the primer has exceeded its maximum usability life and must be discarded.

e. If it can be determined that lack of good adhesion can be attributed to the PR-1531 primer, the primer must be discarded.

1-164. PR-1532 POTTING COMPOUND (PRODUCTS RESEARCH AND CHEMICAL, (SEMCO).

1-165. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Description. Two-part urethane sealant.

c. Type Container. Part A: can; Part B: can.

d. Color. Part A: gray; Part B: white.

e. Consistency. Part A: paste; Part B: spreadable thick paste.

1-166. USABILITY TEST.

WARNING

Potting compound PR-1532 is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

a. Test I.

(1) Remove lids and check each component. Each component must be free of skins, lumps, and coagulations.

(2) Mix appropriate amounts of components together. Both components must be capable of being mixed together to form a smooth, uniform compound.

b. Test II.

(1) If components are not rejected in Test I, thoroughly condition enough of both components at 77° ±5° F for a 50-100 gram sample.

(2) Mix the appropriate amount of curing agent with sample of base compound.

(3) Allow the mixture to cure at 77° ±5° F for 4 hours.

(4) If the catalyzed compound cannot be easily mixed after curing, both components are usable.

(5) If the catalyzed compound can be easily mixed, either the curing agent or the base material has exceeded its usability limit, and each component must be discarded.

1-167. PR-1553 POTTING COMPOUND (PRODUCTS RESEARCH AND CHEMICAL, SEMCO).

1-168. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Description. Two-part urethane molding and potting compound.

c. Type Container. Part A: can; Part B: can.

d. Color. Part A: black; Part B: light amber.

e. Consistency. Part A: thick pourable; Part B: thick pourable.

1-169. USABILITY TEST.

WARNING

Potting compound PR-1553 is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

a. Test I.

(1) Remove lids and check each component. Each component must be free of skins, lumps, and coagulations.

(2) Mix appropriate amounts of components together. Both components must be capable of being mixed together to form a smooth, uniform compound.

b. Test II.

(1) If components pass Test I, thoroughly condition enough of both components at 77° ±5° F for a 50-100 gram sample.

(2) Mix the appropriate amount of curing agent with sample of base compound.

(3) Allow the mixture to cure at 77° ±5° F for 1/2 hour.

(4) If the catalyzed compound cannot be easily mixed after curing both components are usable.

(5) If the catalyzed compound can be easily mixed, either the curing agent or the base material has exceeded its usability life, and each component must be discarded.

1-170. PV100 COATING (VITA-VAR CORP).

1-171. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Specification Ref. RB0125-001, Type I.

c. Description. Heat absorption paint.

d. Type Container. Can.

e. Color. White.

f. Consistency. Thin, pourable.

1-172. USABILITY TEST. Remove lid and check that paint as supplied in its original container is free of skins, lumps, and grit, and is capable of being mixed to a smooth homogeneous condition. If paint cannot meet these conditions, it has exceeded its maximum usability life and must be discarded.

1-173. RB0120-030 EXTERNAL COATING (ROCKETDYNE).

1-174. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Description. Top coat for Larodyne.

c. Type Container. Base, jar or can; catalyst, vial or bottle.

d. Color. Base, white; catalyst, clear to light amber.

e. Consistency. Base, pourable; catalyst, thin, pourable.

1-175. USABILITY TEST

WARNING

External coating RB0120-030 may irritate skin. Protective clothing must be worn when handling coating. In case of contact, wash skin with soap and water.

a. Remove lid and check component A, the base coating. Component A must be a smooth stirable material. If there are any signs of partial self-cure, discard container and its contents.

b. If inspection shows component A to be a smooth stirable material, uniform in consistency, precondition 50-100 grams of component A at room temperature until it attains a temperature of 77° ±5° F. Precondition curing agent, component B, in the same way.

c. Add the appropriate amount of curing agent as directed (5-6 percent) to component A and mix thoroughly for one minute.

d. Allow mixture to stand one hour; then try to mix it.

e. If the catalyzed silicone cannot be easily mixed, both components are usable.

f. If the catalyzed silicone can be mixed, either the curing agent or silicone has exceeded its maximum usability life, and each component must be discarded.

1-176. RB0120-033 ADHESIVE (ROCKETDYNE).

1-177. Refer to vendor number for data on the following types of RB0120-033 Adhesive:

Type RB0120-033	Refer to
Type III, Component A	RTV-560
Type IV, Component A	RTV-560
Type IV, Component B	NUOCURE 28

1-178. RB0120-036 SILICONE PRIMER (ROCKETDYNE).

1-179. Refer to vendor number SS4155 for data.

1-180. RB0125-001, TYPE I, PASSIVE-TEMPERATURE CONTROL COATING (ROCKETDYNE).

1-181. Refer to vendor number PV100 for data.

1-182. RB0130-068 SILICONE-BASE FOAM AND CATALYST (ROCKETDYNE).

1-183. LEADING PARTICULARS.

a. Shelf Life. 6 months at 40° F maximum.

b. Description. Silicone insulation.

c. Type Container. Base, jar; catalyst, vial.

d. Color. Base, brown; catalyst, clear to light amber.

e. Consistency. Base, dry dough; catlayst, thin, easily pourable.

1-184. USABILITY TEST.

WARNING

Silicone-base foam and catalyst RB0130-068 may irritate skin. Protective clothing must be worn when handling material. In case of contact, wash skin with soap and water.

a. Remove lids and measure out enough of both components for at least a 100 gram sample. Precondition both components at 77° ±5° F.

b. Thoroughly mix both components by adding catalyst to silicone base material as directed (two-step process).

c. Spread or flatten out catalyzed compound into a 1/4 to 1/2 inch sheet and allow to cure for one hour.

d. Inspect material to determine if thorough cure has taken place. (This material foams little and its strength is very poor.) If test sample crumbles easily, the silicone base and catalyst have exceeded their maximum usability life and must be discarded.

1-185. RTV-102 WHITE SEALANT (GENERAL ELECTRIC).

1-186. LEADING PARTICULARS.

a. Shelf Life. 6 months for AB0120-057.
12 months for AB0120-013.

b. Specification Ref. AB0120-057 and AB0120-013.

AB0120-057 supersedes AB0120-013 for future procurement. RTV-102 white sealant conforming to specification AB0120-013 may be used until the supply is exhausted.

c. Description. One-part silicone adhesive.

d. Type Container. Tube.

e. Color. White.

f. Consistency. Soft, spreadable, thick paste.

1-187. USABILITY TEST.

WARNING

White sealant RTV-102 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Remove cap and remove any cured or partially cured adhesive blocking or present at tube opening.

b. Squeeze tube. If the adhesive cannot be squeezed out after freeing plugged opening, discard adhesive.

c. If, when attempting to squeeze out adhesive, the tube is punctured or ruptures, discard adhesive.

d. If the adhesive can be squeezed out and lumps can be detected other than lumps from the plugged or partially plugged opening, discard adhesive.

e. If the adhesive is not rejected by one of the above steps, the adhesive is usable.

1-188. RTV-103 BLACK SEALANT (GENERAL ELECTRIC).

1-189. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. One-part silicone adhesive.

c. Type Container. Tube.

d. Color. Black.

e. Consistency. Soft, spreadable, thick paste.

1-190. USABILITY TEST.

WARNING.

Black sealant RTV-103 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Remove cap and remove any cured or partially cured adhesive blocking or present of tube opening.

b. Squeeze tube. If the adhesive cannot be squeezed out after freeing plugged opening, discard adhesive.

c. If, when attempting to squeeze out adhesive, the tube is punctured or ruptures, discard adhesive.

d. If the adhesive can be squeezed out and lumps can be detected other than lumps from the plugged or partially plugged opening, discard adhesive.

e. If the adhesive is not rejected by one of the above steps, the adhesive is usable.

1-191. RTV-11 SILICONE RUBBER (GENERAL ELECTRIC).

1-192. LEADING PARTICULARS.

a. Shelf Life. 6 months at 80° F maximum. 12 months at 0° F or below.

b. Specification Ref. RB0120-005.

c. Description. Two-part silicone rubber.

d. Type Container. Base, bulk; curing agent, tube or bottle.

e. Color. Base, white; curing agent, clear to light amber.

f. Consistency. Base, easily pourable; curing agent, thin, easily pourable.

1-193. USABILITY TEST.

WARNING

Silicone rubber RTV-11, when mixed with catalyst must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

a. Test I. This test is to be used to determine whether both uncured silicone rubber and curing agent are within usability limits. To test usability of uncured silicone rubber alone, refer to Test II. To test usability of curing agent alone, see appropriate usability test of Thermolite 12 or Nuocure 28.

(1) Weigh out a 50-100 gram sample of uncured silicone rubber and precondition at 77° ±5° F.

(2) Condition curing agent in same manner and add correct amount of curing agent to uncured silicone rubber sample. Mix thoroughly for one minute.

(3) Allow mixture to set for 4 hours at 77° ±5° F; then try to mix catalyzed silicone. If catalyzed silicone cannot be mixed easily, the uncured rubber and curing agent are usable. If mixture can be easily mixed, the curing agent or silicone has exceeded its maximum usability life.

(4) If time permits; isolate the component hindering cure as outlined in Test II.

(5) Discard each uncured silicone rubber batch and curing agent tested.

b. Test II. This test is to be used only for determining usability of uncured silicone rubber.

(1) Precondition, at 77° ±5° F, the appropriate amount of curing agent from a batch known to have demonstrated curing ability.

(2) Weigh out a 50-100 gram sample of uncured silicone rubber in question, and precondition at 77° ±5° F.

(3) Add appropriate amount of conditioned curing agent to conditioned uncured silicone rubber sample. Mix thoroughly for one minute and allow to stand for 4 hours.

(4) After 4 hours, try to mix catalyzed silicone. If mixture cannot be easily mixed, the uncured silicone rubber is usable.

(5) If mixture can be easily mixed, the uncured silicone rubber has exceeded its maximum usability life. Discard each tested container, and additional containers from same lot number stored under same conditions.

1-194. RTV-560 ADHESIVE (GENERAL ELECTRIC)

1-195. LEADING PARTICULARS.

a. Shelf Life. 6 months at 80° F maximum.
12 months at 0° F or below.

b. Specification Ref. RB0120-005
RB0120-029
RB0120-033

c. Description. Two-part silicone rubber.

d. Type Container. Base, bulk; curing agent, tube or bottle.

e. Color. Base, red; curing agent, clear to light amber.

f. Consistency. Base, pourable; curing agent, thin, easily pourable.

1-196. USABILITY TEST.

WARNING

Adhesive RTV-560, when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

a. Test I. This test is to be used to determine whether both uncured silicone rubber and curing agent are within usability limits. To test usability of uncured silicone rubber alone, refer to Test II. To test usability of curing agent alone, see appropriate usability test of Thermolite 12 or Nuocure 28.

(1) Weigh out a 50-100 gram sample of uncured silicone rubber and precondition at 77° ±5° F.

(2) Condition curing agent in same manner and add correct amount of curing agent to uncured silicone rubber sample. Mix thoroughly for one minute.

(3) Allow mixture to set for 4 hours at 77° ±5° F; then try to mix catalyzed silicone. If catalyzed silicone cannot be mixed easily, the uncured rubber and curing agent are usable. If mixture can be easily mixed, the curing agent or silicone has exceeded its maximum usability life.

(4) If time permits, isolate the component hindering cure as outlined in Test II.

(5) Discard each uncured silicone rubber batch and curing agent tested.

b. Test II. This test is to be used only for determining usability of uncured silicone rubber.

(1) Precondition, at 77° ±5° F, the appropriate amount of curing agent from a batch known to have demonstrated curing ability.

(2) Weigh out a 50-100 gram sample of uncured silicone rubber in question, and precondition at 77° ±5° F.

(3) Add appropriate amount of conditioned curing agent to conditioned uncured silicone rubber sample. Mix thoroughly for one minute and allow to stand for 4 hours.

(4) After 4 hours, try to mix catalyzed silicone. If mixture cannot be easily mixed, the uncured silicone rubber is usable.

(5) If mixture can be easily mixed, the uncured silicone rubber has exceeded its maximum usability life. Discard each tested container, and additional container from same lot number stored under same conditions.

1-197. SF-250-C6-RTV-102 SEALANT (PRODUCTS RESEARCH AND CHEMICAL, SEMCO).

1-198. LEADING PARTICULARS.

a. Shelf Life. 6 months for AB0120-057.
12 months for AB0120-013.

b. Specification Ref. AB0120-057 and AB0120-013.

AB0120-057 supersedes AB0120-013 for future procurement. SF-250-C6-RTV-102 sealant conforming to specification AB0120-013 may be used until the supply is exhausted.

c. Description. One-part silicone adhesive.

d. Type Container. Cartridge.

e. Color. White.

f. Consistency. Soft, spreadable, thick paste.

1-199. USABILITY TEST.

WARNING

White sealant RTV-102 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Remove cap and remove any cured or partially cured adhesive blocking or present at cartridge opening.

b. Squeeze cartridge. If the adhesive cannot be squeezed out after freeing plugged opening, discard adhesive.

c. If, when attempting to squeeze out adhesive, the cartridge is punctured or ruptures, discard adhesive.

d. If the adhesive can be squeezed out and lumps can be detected other than lumps from the plugged or partially plugged opening, discard adhesive.

e. If the adhesive is not rejected by one of the above steps, the adhesive is usable.

1-200. SF-667-RTV560/9950 ADHESIVE (PRODUCTS RESEARCH AND CHEMICAL, SEMCO).

1-201. LEADING PARTICULARS.

a. Shelf Life. 6 months at 60° F maximum.
None at -7° F or below.

b. Specification Ref. RB0120-029.

c. Description. Two-part silicone rubber.

d. Type Container. Base, cartridge; curing agent, jar.

e. Color. Base, red; curing agent, white.

f. Consistency. Base, easily pourable; curing agent, paste.

1-202. USABILITY TEST.

WARNING

Adhesive SF-667-RTV560/9950, when mixed, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 12 minutes; wash skin with soap and water; and get medical attention.

a. Precondition silicone rubber and curing agent at 77° ±5° F. Mix both components as directed by supplied instructions, and place a quantity of catalyzed silicone compound in a container.

b. Allow sample to stand 2 hours; then try to stir mixture.

c. If the mixture cannot be easily stirred, all containers with the same number or manufacturing date are usable.

d. If the mixture can be easily stirred, all containers having same batch number or manufacturing date that have been stored under the same conditions must be discarded.

1-203. SS-4155 SILICONE PRIMER (GENERAL ELECTRIC).

1-204. LEADING PARTICULARS.

a. Shelf Life. 6 months at 80° F maximum.

b. Specification Ref. RB0120-036.

c. Description. Silicone primer.

d. Type Container. Bottle.

e. Color. Blue.

f. Consistency. Thin, easily pourable.

1-205. USABILITY TEST.

WARNING

Silicone primer SS-4155 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Test I.

(1) Mix primer and apply a thin coat to a test sample that has been solvent-cleaned. Visually check its appearance every 15 minutes for one hour. The physical appearance of the primer during its one hour drying cycle should progress from a wet to a dry powdery stage without any appearance of an oily condition.

(2) If any oily appearance is observed during any intermediate stage of dryness, reprepare surface to be primed as directed. Reapply the primer and if the oily appearance again appears, discard primer only if it can be determined that the surface being primed is not at fault.

b. Test II.

(1) Mix primer and test specific gravity of primer by the hydrometer method. Specific gravity of the primer must fall within the range 0.79 to 0.85, and the following conditions met:

(a) The hydrometer used must be graduated in increments, not greater than 0.01 specific gravity units.

(b) The hydrometer cylinder's inside diameter must be at least 25 mm (one inch) greater than the largest outside diameter of the hydrometer float.

(c) The primer sample must be at the same temperature at which the hydrometer was calibrated.

(2) If duplicate samples of the primer do not fall within the correct range, the primer has exceeded its maximum usability life and must be discarded.

(3) If the primer is not rejected in Test I and Test II, the primer is usable.

1-206. THERMOLITE 12 (M&T CHEMICALS, INC).

1-207. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Specification Ref. RB0120-005
RB0120-029, Type IV

c. Description. Dibutyl tin dilaurate curing agent.

d. Type Container. Tube or bottle.

e. Color. Clear to light amber.

f. Consistency. Thin, easily pourable.

1-208. USABILITY TEST.

WARNING

Curing agent Thermolite 12 must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling curing agent. In case of contact, flush eyes with water for at least 15 minutes; wash skin with soap and water; and get medical attention.

a. Weigh out a 50-100 gram sample of uncured silicone that has previously demonstrated the ability to be cured. Precondition the uncured silicone and curing agent at 77° ±5° F.

b. Mix appropriate amounts of components together for one minute.

c. Note the type of silicone rubber base being used and allow the mixture to stand the recommended test time interval listed below; then try to mix it.

Type Silicone	Test Time (Hr)
RTV-11	4
RTV-30	2
RTV-60	3
RTV-88	2
RTV-90	1
RTV-511	3
RTV-560	2

d. If catalyzed silicone cannot be easily mixed, the curing agent is usable.

e. If the catalyzed silicone can be mixed, the curing agent has exceeded its maximum usability life, and must be discarded.

1-209. URALANE 5712 POTTING COMPOUND (FURANE PLASTICS, INC).

1-210. LEADING PARTICULARS.

a. Shelf Life. 6 months.

d. Description. Two-part potting and molding compound.

c. Type Container. Base, can; catalyst, can.

d. Color. Base, light amber; catlayst, dark brown.

e. Consistency. Base, pourable; catalyst, thick, pourable.

1-211. USABILITY TEST.

WARNING

Potting compound Uralane 5712 is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

a. Test I.

(1) Remove lids and check each component. Each component must be free of skins, lumps, and coagulations.

(2) Mix appropriate amounts of components together. Both components must be capable of being mixed together to form a smooth, uniform compound.

b. Test II.

(1) If components pass Test I, thoroughly precondition enough of both components at 77° ±5° F for a 50-100 gram sample.

(2) Mix the appropriate amount of curing agent with sample of base compounds.

(3) Allow mixture to cure at 77° ±5° F for 1-1/2 hours.

(4) If catalyzed compound cannot be easily mixed after curing both components are usable.

(5) If the catalyzed compound can be easily mixed, either the curing agent or the base material has exceeded its usability life, and each component must be discarded.

1-212. VERSAMID 125 (GENERAL MILLS).

1-213. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. Polyamid resin.

c. Type Container. Can.

d. Color. Amber.

e. Consistency. Thin, pourable.

1-214. USABILITY TEST.

WARNING

Polyamid resin Versamid 125 may irritate skin. Protective clothing must be worn when handling resin. In case of contact, wash skin with soap and water.

a. Test I.

(1) Remove lid and pour out a sample of resin into a smaller container.

(2) Visually inspect sample. Sample must be free of lumps, crystallization, or coagulation. If sample is not a smooth, uniform, pourable liquid, discard resin.

WARNING

Epoxy resin Epon 828 may irritate skin. Protective clothing must be worn when handling resin. In case of contact, wash skin with soap and water.

b. Test II.

(1) If resin is not rejected in Test I, thoroughly mix 50 grams of resin with 120 grams of epozy resin, eg, EPON 828, known to have previously exhibited cure properties.

(2) If EPON 828 epoxy resin is used, allow mixure to stand 6 hours at 77° ±5° F. (Consult literature or Rocketdyne Materials and Processes for correct formulations and cure times when other resins are used.)

(3) Try to stir mixure after it has set for 6 hours.

(4) If there is difficulty in stirring or if mixture cannot be stirred, the resin is usable.

(5) If it can be easily stirred and it can be demonstrated that the epoxy resin is not the component inhibiting cure, the resin has exceeded its maximum usability life and must be discarded.

1-215. VK-193-0030 ADHESIVE (NAVAN, INC).

1-216. LEADING PARTICULARS.

a. Shelf Life. 6-9 months at 78° F maximum.

b. Description. One-part adhesive.

c. Type Container. Can.

d. Color. Brown.

e. Consistency. Thick syrup.

1-217. USABILITY TEST.

a. Test I.

(1) Remove lid and check adhesive. Adhesive must be free of skins, lumps, and coagulation.

(2) Apply adhesive to a smooth surface. Adhesive must flow a thin, even coat.

b. Test II.

(1) If adhesive is not rejected in Test I, apply a thin, even coat of adhesive to sample surfaces to be bonded. (The samples should be of materials recommended to be bonded by this adhesive and be flat and smooth.)

(2) Allow adhesive to dry to an aggressively tacky stage (evidenced by adhering but not transferring to the finger when touched); then join surfaces and roll or press firmly to ensure contact.

(3) If an aggressively tacky stage cannot be attained or if an effective bond cannot be achieved from the two samples joined together, adhesive has exceeded its maximum usability life and must be discarded.

1-218. 56C ECCOBOND SOLDER (EMERSON AND CUMMINGS).

1-219. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. Electrically conductive adhesive.

c. Type Container. Solder base, jar; catalyst No. 9, can; catalyst No. 11, bottle.

d. Color. Solder base, silver; catalyst No. 9, light amber; catalyst No. 11, dark brown.

e. Consistency. Solder base, smooth paste; catalyst, thin, easily pourable.

1-220. USABILITY TEST.

WARNING

Solder Eccobond 56C may irritate skin. Protective clothing must be worn when handling solder. In case of contact, wash skin with soap and water.

a. Mix correct amount of catalyst No. 9 or No. 11 with a small quantity of solder base, as directed

b. Place mixture in a 150° F oven. Cure should take place within 10 minutes using catalyst No. 9 or 4 hours using catalyst No. 11. If catalyst No. 11 is used, cure should take place within one hour if placed in a 250° F oven.

c. If cure does not take place in the specified time, both components must be discarded.

1-221. 584 ADHESIVE (COAST PRO-SEAL).

1-222. LEADING PARTICULARS.

a. Shelf Life. 12 months.

b. Description. One-part adhesive.

c. Type Container. Can.

d. Color. Tan.

e. Consistency. Thin syrup.

1-223. USABILITY TEST.

WARNING

Adhesive 584 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the adhesive can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. Test I.

(1) Remove lid and check adhesive. Adhesive must be free of skins, lumps, and coagulation.

(2) Apply adhesive to a smooth surface. Adhesive must flow in a thin, even coat.

b. Test II.

(1) If adhesive is not rejected in Test I, apply a thin, even coat of the adhesive to sample surfaces to be bonded together. (The samples should be of materials recommended to be bonded by this adhesive and be flat and smooth.)

(2) Allow adhesive to dry to an aggressively tacky stage (evidenced by adhering but not transferring to the finger when touched); then join surfaces and roll or press firmly to ensure contact.

(3) If an aggressively tacky stage cannot be attained or if an effective bond cannot be achieved from two samples joined together, the adhesive has exceeded its maximum usability life and must be discarded.

1-224. 587.3 PRESSTITE TAPE (INTER-CHEMICAL CORP).

1-225. LEADING PARTICULARS.

a. Shelf Life.

(1) 3 months at 100° F or less (ambient).

(2) 6 months at 45° F or less (refrigerated).

(3) 12 months at -7° F or less (frozen).

1-226. USABILITY TEST. No usability testing is allowed. Material is disposed of at expiration of shelf life. To meet shelf life requirements of refrigerated or frozen Presstite, compound must be stored in a plastic bag with the open end tied with string or wire. Heat sealing, vaporproof materials, individual bagging, etc, may be used. Sealant must be kept at ambient temperature for 24 hours before used.

1-227. 910 CEMENT (EASTMAN).

1-228. LEADING PARTICULARS.

a. Shelf Life. 6 months.

b. Description. Anaerobic adhesive.

c. Type Container. Plastic bottle.

d. Color. Clear.

e. Consistency. Thin, easily pourable.

1-229. USABILITY TEST.

WARNING

Cement 910 is toxic. Inhalation of its vapors or contact with the material can cause serious bodily harm. It must be used in a well-ventilated area. In case of contact, wash skin with soap and water.

a. Remove cap and squeeze bottle. If opening is not obstructed and adhesive cannot be squeezed out of bottle, dispose of bottle and its contents.

b. If the adhesive can be squeezed out of its container, apply a thin, even coat of adhesive to sample surfaces to be bonded. (The samples should be of material recommended to be bonded by this adhesive and be flat and smooth).

c. If sample materials cannot be bonded, choose two dry, smooth, solvent-cleaned metal samples and apply a drop of adhesive to one surface of one of the metal samples.

d. Try to bond other metal sample to metal sample containing the adhesive by applying pressure with palm of hand or between the fingers for one minute. Do not allow samples to slip under pressure. If samples cannot be easily pulled apart after one minute, adhesive has not exceeded its maximum usability life. If samples can be easily pulled apart, adhesive has exceeded its usability life and must be discarded.

1-230. 92-018 AEROSPACE SEALANT (DOW CORNING CORP).

1-231. LEADING PARTICULARS.

a. Shelf Life. 6 months for AB0120-057.
12 months for AB0120-013.

b. Specification Ref. AB0120-057 and AB0120-013.

AB0120-057 supersedes AB0120-013 for future procurement. 92-018 Aerospace Sealant conforming to specification AB0120-013 may be used until the supply is exhausted.

c. Description. One-part silicone adhesive.

d. Type Container. Tube or cartridge.

e. Color. Black.

f. Consistency. Soft, spreadable, thick paste.

1-232. USABILITY TEST.

a. Remove cap and remove any cured or partially cured adhesive blocking or present at container opening.

b. Squeeze container. If adhesive cannot be squeezed out after freeing plugged opening, discard adhesive.

c. If, when attempting to squeeze out adhesive, the container is punctured or ruptures, discard adhesive.

d. If the adhesive can be squeezed out and lumps can be detected other than lumps from the plugged or partially plugged opening, discard adhesive.

e. If the adhesive is not rejected by one of the above steps, the adhesive is usable.

1-233. COMPONENT RETEST REQUIREMENTS.

1-234. The following spare components must be retested within the time period indicated. Refer to R-3825-3 Volume II for component retest procedures.

Component	Test required within one week before installation
Armored harness	Continuity and insulation resistance tests.
ECA	Pressure check.
Flight instrumentation packages	Pressure check.
Helium fill check valve	Flow and reverse leakage tests.
Ignition detector probe	Resistance measurements.
Mainstage OK switches[a]	Functional test and stress corrosion inspection.
Purge and seal drain check valves	Flow and reverse leakage tests.
Solenoid valves	Coil and insulation resistance tests.
Start tank discharge valve	Bellows seal leak test.
Start tank refill check valve manifold 307599-41	Flow and reverse leakage tests.
Start tanks support and fill valve	Flow and reverse leakage tests.
Transducers	As specified for type.
Vent port check valves	Opening pressure, flow and reverse leakage tests.

(a) Retest six months before installation also.

SECTION II

HANDLING

WARNING

THE FOLLOWING GROUND SUPPORT EQUIPMENT MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

G4035, Engine Vertical Installer
G4042, Engine Forward Sling
G4045, Engine Aft Sling
G4064, Engine Handler
G4071, Engine Components Installer
G4072, Engine Components Installer

2-1. SCOPE. This section contains procedures for handling the engine using the ground support equipment. The tasks include transferring the engine from and to the transportation vehicle, transferring the engine from and to the engine handler and vertical installer, and lowering and raising installed engines for component removal and installation.

Figure 2-1 deleted.

2-2. REMOVING ENGINE AND HANDLER FROM TRANSPORTATION VEHICLE.

2-3. This procedure uses a forklift to remove the handler with engine from a transportation vehicle. Where the handler with engine can be off-loaded by rolling it off the transportation vehicle, the requirements are obvious and are therefore not provided.

a. Obtain a forklift with 40-inch-minimum lever arms and 15,000-pound-minimum capacity.

NOTE

The engine with handler weighs approximately 7,100 pounds. The center of gravity is within 2 inches of the center from the sides of the handler.

b. Engage wheel brakes on rear casters of engine handler.

c. Loosen and remove tiedown cables between transport vehicle and handler tiedown rings.

d. Using forklift, raise handler from transport vehicle and place on level floor in working area.

e. Make sure that wheel brakes are still engaged; then remove forklift.

2-4. INSTALLING ENGINE AND HANDLER ON TRANSPORTATION VEHICLE.

2-5. This procedure uses a forklift to install the handler with engine on a transportation vehicle. Where the handler with engine can be onloaded by rolling it onto the transportation vehicle, the requirements (except tiedown) are obvious and are therefore not provided. Tiedown requirements are provided in figure 2-2.

a. Obtain a forklift with 40-inch-minimum lever arms and 15,000-pound-minimum capacity.

NOTE

The engine with handler weighs approximately 7,100 pounds. The center of gravity is within 2 inches of the center from the sides of the handler.

b. Make sure engine cover is installed and secured around lower perimeter. (Refer to paragraph 2-16.)

c. To prevent wind damage to the engine cover, it is recommended that the engine and handler be transported in a closed vehicle. If not transported in a closed vehicle, the cover must be protected against wind velocities more than 20 mph.

d. Engage wheel brakes on rear casters of engine handler.

e. Using forklift, install engine and handler on transport vehicle with aft end of handler forward, relative to direction of travel of transporting vehicle. Aft end of handler is end with removable gates.

f. Secure engine handler to transport vehicle using flexible steel cables, log chains, or heavy-gage steel straps, as shown in figure 2-2, for the appropriate mode of transportation. If transport is by truck, use tiedowns capable of withstanding 4,700 pounds applied load. If transport is by air, use tiedowns capable of withstanding 17,000 pounds applied load.

g. Unlock wheel brakes.

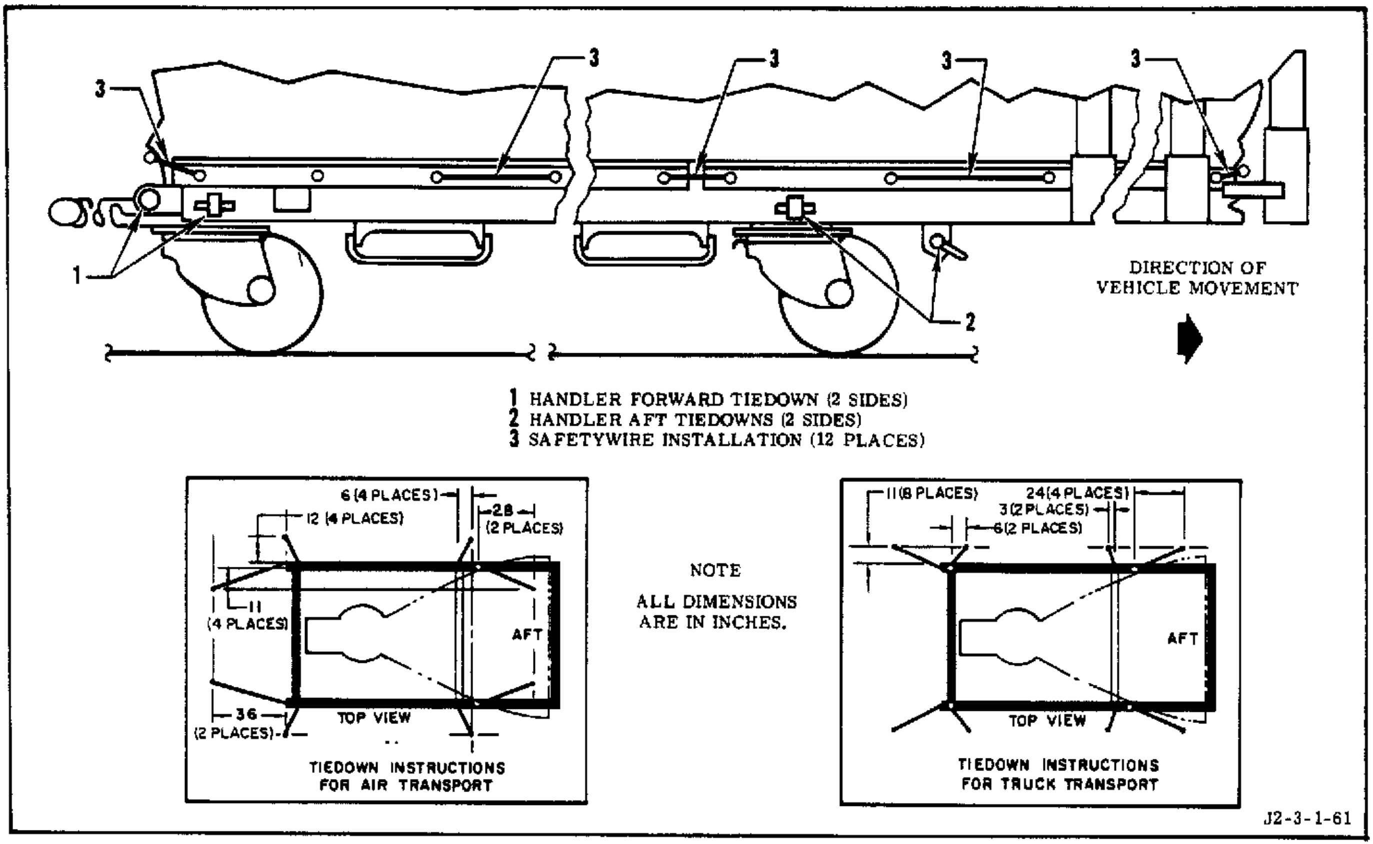


Figure 2-2. Engine Handler Tiedown

2-6. REMOVING ENGINE FROM HANDLER.

2-7. This procedure disconnects and removes the engine from the handler and leaves the engine suspended in a vertical attitude. To complete the engine handling task, a reference is made at the end of this procedure to the appropriate paragraph for installing the engine on the selected handling equipment.

a. Obtain the following:

(1) Work area containing two overhead hoists capable of lifting 4,000 and 1,500 pounds, respectively. Hoists must be capable of being placed within 8 feet of each other.

(2) Engine Forward Sling G4042MD1 or 99-9024384

(3) Engine Aft Sling G4045

b. Remove engine cover (paragraph 2-8).

c. Prepare engine for handling (paragraph 2-10).

d. Prepare handling equipment onto which engine is to be installed (paragraph 2-14 or 2-22), and position prepared handling equipment in area serviced by overhead hoists.

e. Attach engine forward sling to overhead hoist capable of lifting 4,000 pounds, and position forward end of engine under hoist and sling.

f. Connect sling to fuel-side engine handling adapter; then position sling on oxidizer-side engine handling adapter, and install captive attach pin.

g. Attach engine aft sling to overhead hoist capable of lifting 1,500 pounds. Make sure sling lockpins are in stowed position (upper holes in sling).

h. Position 1,500-pound hoist over aft end of thrust chamber and approximately 8 feet from 4,000-pound hoist. Attach sling to lifting lug on thrust chamber.

i. Disconnect fluid line support from engine handler by removing 4 lockpins.

NOTE

See figure 2-3 for identification of mounting points referenced in steps j through p.

j. Remove fastener inserted in ball mount at forward end of engine, mounting point A.

k. Slowly raise engine with engine aft sling until weight of engine is relieved from mounting point C1.

l. Remove lockpin from mounting point C1.

m. Continue to raise engine with engine aft sling until weight of engine is relieved from mounting point C2.

CAUTION

Failure to prevent the yoke from rotating until the engine clears the yoke can result in damage to the engine.

n. Hold yoke of engine handler to prevent it from rotating, and remove lockpin from mounting point C2. Raise aft end of engine until it clears yoke; rotate yoke forward to rest on handler base.

o. Release and hold spring-actuated slider located at mounting point B; raise engine with engine forward sling until ball socket is clear of ball mount at mounting point A.

p. Carefully move engine aft to clear pin at point B.

q. Lift engine clear of handler with both forward and aft engine slings.

r. Move engine away from handler, or unlock handler brakes and move handler from under engine.

s. Slowly lower thrust chamber end of engine while raising forward end until engine is wholly supported by 4,000-pound hoist.

t. Remove engine aft sling unless engine is to be reinstalled on a handler, in which case leave sling attached.

u. Install dust cover on engine handler.

v. Complete task by installing engine on vertical installer (paragraph 2-20) or on engine handler (paragraph 2-12).

2-8. REMOVING ENGINE COVER.

2-9. Remove engine cover as follows:

a. Remove gates from handler, and stow gates away from immediate working area.

b. Disengage captive bolts around frame of handler, and swing hinged over-retaining strips out to free engine cover. When cover is free, fasten retaining strips to handler by tightening captive bolts. Torque bolts to 5-10 in-lb.

c. Remove cover sling components from handler storage compartment. Assemble sling and connect to an overhead hoist and to protective security cover.

d. Make sure engine cover is free from engine handler and will not snag on engine; then hoist cover and lower it onto a clean area. Fold (R-3825-5) and place cover in its pouch and stow in handler storage compartment.

e. Disassemble cover sling and stow in handler storage compartment.

2-10. PREPARING ENGINE FOR HANDLING.

2-11. This procedure installs adapters for the engine forward sling, inspects the lifting lug on the thrust chamber, and if the engine is to be set on its exit flange, makes sure the proper thrust chamber exit closure is installed.

a. Attach engine handling adapters to forward end of engine at thrust chamber. Lubricate (Method A, section I) bolt threads on adapters RX20899 and RX20900 with sealing and antiseize compound RB0140-005 (Rocketdyne). Torque adapter RX20899 bolts to 405-495 in-lb and adapter RX20900 bolts to 432-528 in-lb. Safetywire bolts.

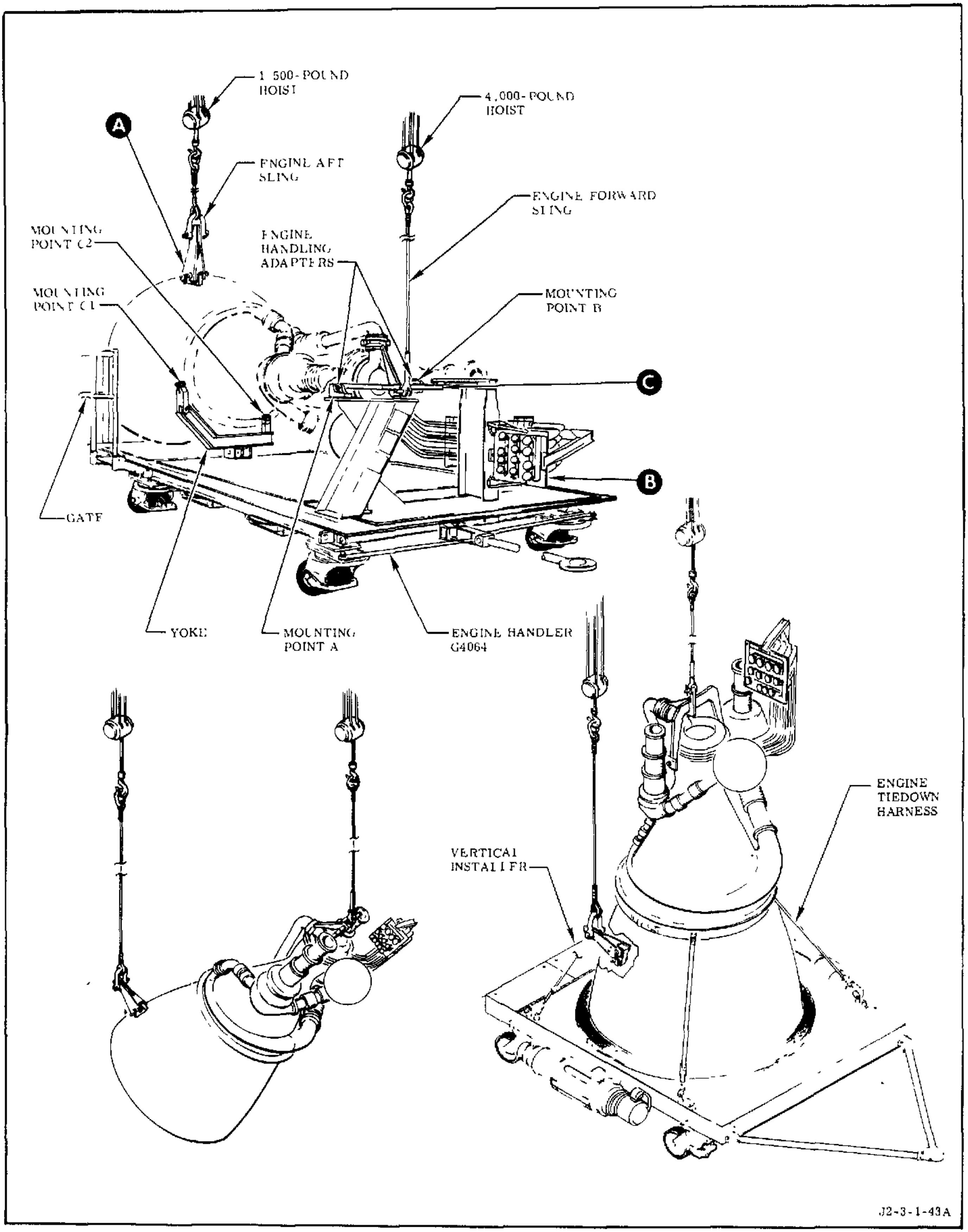


Figure 2-3. Engine Handling Method and Attach Points (Sheet 1 of 2)

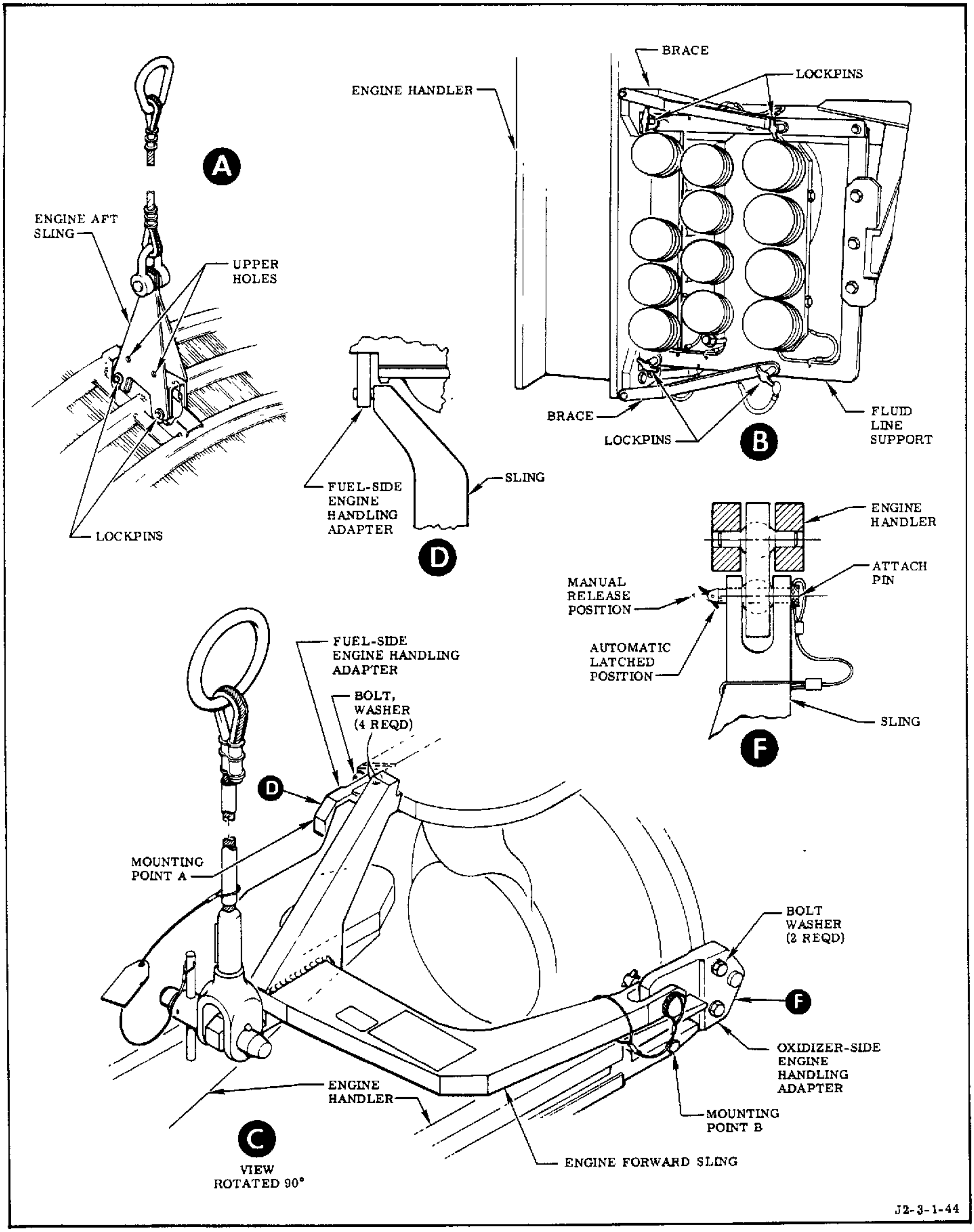


Figure 2-3. Engine Handling Method and Attach Points (Sheet 2 of 2)

b. On engines incorporating MD338 change, remove 2 nuts and washers from bolts that secure dummy ignition detector probe bracket to flange of hydrogen tank pressurization line; secure probe, cable, and bracket out of the way.

c. Inspect lifting lug on thrust chamber for cracks around lift holes and welds.

CAUTION

Placing the engine in a vertical position on the thrust chamber exit closure that does not have doublers installed between the attaching bolts, or with attaching bolts protruding out past the doublers, can result in damage to the engine.

d. If engine is to be set on its exit flange, make sure that thrust chamber exit closure has doublers installed between closure attaching bolts and that bolts do not protrude out past doublers.

2-12. INSTALLING ENGINE ON HANDLER.

2-13. This procedure assumes that the engine has been removed from either the vertical installer (paragraph 2-18) or handler (paragraph 2-6) and is suspended with the engine forward sling from an overhead hoist.

a. Obtain the following:

(1) Overhead hoist capable of lifting 1,500 pounds and capable of being positioned 3-8 feet from hoist that supports engine

(2) Engine Aft Sling G4045

b. Attach engine aft sling to overhead hoist capable of lifting 1,500 pounds. Make sure sling lockpins are in stowed position (upper holes in sling).

c. Position 1,500-pound hoist and aft engine sling over lifting lug on thrust chamber.

d. Secure engine aft sling to lifting lug on thrust chamber.

e. Using aft sling hoist, raise thrust chamber, until engine is parallel to floor.

f. Position engine over handler, or roll handler under engine.

NOTE

See figure 2-3 for identification of mounting points referenced in steps g through q.

g. Carefully lower engine, and aline engine and handler so that oxidizer side handling adapter alines with slotted clevis at mounting point B.

h. Lock handler brakes.

i. Slowly manipulate engine until adapter enters slot, drops in hole, and is secured in place by spring-actuated slider.

NOTE

When viewing the engine from the thrust chamber exit, the engine line of thrust in relation to the handler must be slightly to the right of center at the aft end and slightly below center at the forward end.

j. Carefully lower engine until socket in fuel side handling adapter is seated on ball at mounting point A.

k. Install fastener at mounting point A, and torque bolt to 20-4 in-lb.

l. Position and hold engine handler yoke upright; then slowly lower aft end of engine until engine lug is mated with clevis on yoke at mounting point C2. Install lockpin through clevis.

m. Bring lug on thrust chamber in line with clevis on yoke at mounting point C1. Install lockpin through clevis at mounting point C1 to secure aft end of engine.

n. Permit handler to assume full weight of engine.

o. Disconnect and remove forward sling from engine by supporting sling and disconnecting from oxidizer side of engine, then from fuel side of engine.

p. On engines incorporating MD338 change, install dummy ignition detector probe and bracket on flange of hydrogen tank pressurization line with 2 bolts, washers, and nuts. Torque nuts to 30-40 in-lb.

q. Secure fluid lines interface support to engine handler with 4 lockpins.

r. Torque bolt on fastener installed on mounting point A to 400-500 in-lb.

s. Safetywire head of fastener bolt.

t. Install handler gates on handler aft end.

u. Install engine cover as outlined in paragraph 2-16.

2-14. PREPARING ENGINE HANDLER.

2-15. Prepare engine handler as follows:

a. Position engine handler on level floor near engine; then engage rear-wheel brakes.

b. Remove handler dust cover from engine handler, fold and place cover in its protective pouch,and stow pouch in handler storage compartment.

c. Inspect engine handler to make sure that it is in good working order. Make sure that all mounting hardware functions properly and all captive hardware hangs loose.

d. Remove handler gates from aft end of handler and stow them away from immediate working area.

2-16. INSTALLING ENGINE COVER.

2-17. Install engine cover as follows:

a. Remove engine cover and cover sling from handler storage compartment.

b. Assemble and attach cover sling to overhead hoist and to engine cover. Hoist and arrange cover over mounted engine assembly so that padding built into cover coincides with engine and handler projections.

c. Position bead of engine cover so that it is held in position evenly and firmly by hinged cover-retaining strips. Secure retaining strips with captive bolts. Torque bolts to 20-26 in-lb.

d. Safetywire captive bolts at each end and in center of each retaining strip. (See figure 2-2.) Attach a seal at end of lockwire.

2-18. REMOVING ENGINE FROM VERTICAL INSTALLER.

2-19. This procedure removes the engine from the vertical installer and leaves the engine suspended in a vertical attitude. To complete the engine handling task, a reference is made to the appropriate paragraph for installing the engine on the selected handling equipment.

a. Obtain the following:

(1) Work area containing an overhead hoist capable of lifting 4,000 pounds

(2) Engine Forward Sling G4042MD1 or 99-9024384

b. Make sure engine is prepared for handling (paragraph 2-10).

c. Prepare handling equipment onto which engine is to be installed (paragraph 2-14 or 2-22), and position prepared handling equipment in area serviced by overhead hoist.

d. Attach engine forward sling to overhead hoist capable of lifting 4,000 pounds.

e. Aline sling and engine.

f. Connect sling to fuel side engine handling adapter; then position sling on oxidizer side engine handling adapter, and install captive attach pin.

g. Remove engine tiedown harness from vertical installer and engine. Stow tiedown harness in PARTS STOWAGE compartment.

CAUTION

Minimal clearance exists between the oxidizer pump seal drain line and the vertical installer. Contact with the vertical installer can damage the line.

h. Using hoist, raise engine clear of installer. Monitor oxidizer pump seal drain line, and prevent drain line from contacting installer.

i. Move engine away from installer or unlock installer wheel brakes and move installer from under engine.

j. Complete task by installing engine on engine handler (paragraph 2-12) or on vertical installer (paragraph 2-20).

2-20. INSTALLING ENGINE ON VERTICAL INSTALLER.

2-21. This procedure assumes that the engine has been removed from either the vertical installer (paragraph 2-18) or handler (paragraph 2-6) and is suspended with the engine forward sling from an overhead hoist.

a. Make sure vertical installer is prepared. (Refer to paragraph 2-22.)

CAUTION

> Placing the engine in a vertical position on the thrust chamber exit closure that does not have doublers installed between the attaching bolts, or with attaching bolts protruding out past the doublers, can result in damage to the engine.

b. Make sure that thrust chamber exit closure has doublers installed between closure attaching bolts and that bolts do not protrude past doublers.

c. Hold engine a minimum of 3 feet from floor. Move engine over installer, or roll installer under engine.

CAUTION

> Minimal clearance exists between the oxidizer pump seal drain line and the vertical installer. Contact with the vertical installer can damage the drain line.

d. Lower engine to within 6 inches of installer ring. Monitor oxidizer pump seal drain line, and prevent drain line from contacting installer.

e. Visually check that engine is centered over retainer ring. Move installer and/or engine to effect alinement that prevents any contact between engine and installer that could result in damage to engine.

f. Slowly lower engine to vertical installer until installer supports entire weight of engine. Monitor oxidizer pump seal drain line, and prevent drain line from contacting installer. The thrust chamber must be visually centered on the rubber pad.

g. Disconnect and remove engine forward sling from engine by supporting sling and disconnecting from oxidizer side of engine, then from fuel side of engine.

h. Remove sling from hoist.

i. On engine incorporating MD338 change, install dummy ignition detector probe and support bracket on flange of hydrogen tank pressurization line with 2 bolts, washers, and nuts. Torque nuts to 30-40 in-lb.

j. Install engine tiedown harness. (See figure 2-3.) Position buckle of girth strap under fuel pump.

2-22. PREPARING VERTICAL INSTALLER.

2-23. The installer supports the engine on a circular support ring which can be set to one of two elevations. Preparing the installer for use consists of setting the support ring to the selected elevation and moving the installer to the area where the engine is to be installed. Selection of elevation to which the support ring is to be set is governed by local conditions. With the support ring at the higher elevation, a minimum overhead clearance of 177.5 inches is required to clear the engine. The required overhead clearance can be lowered 17.5 inches to a minimum of 160 inches by using the lower elevation. The following procedure can be used to set the support ring to either the upper or lower elevation.

NOTE

> This procedure requires an area servied by an overhead hoist that is capable of lifting a minimum of 1,000 pounds.
>
> - Parts referenced in the following procedure are illustrated in figure 2-4.

a. If installed, remove protective cover from installer and store cover in compartment labeled STOW PARTS NO. 9022099 (and) 19-9021036. On installers incorporating MD4 change, fold and lay cover on installer clear of support ring.

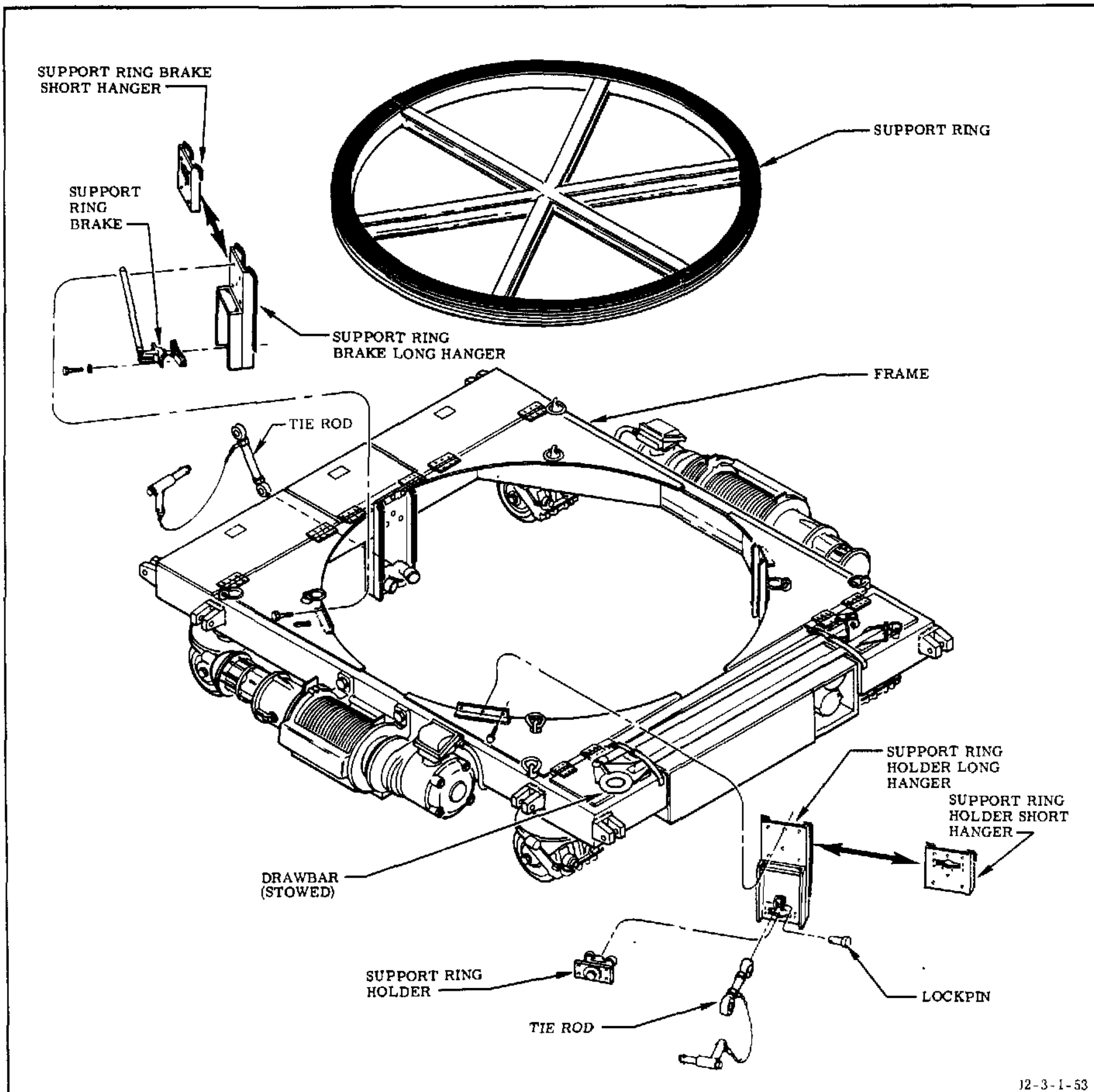


Figure 2-4. Positioning Vertical Installer Support Ring

b. Obtain support ring hangers to be installed. If support ring is to be placed at the lower elevation, the required hangers are clamped to the underside of the support ring. If the support ring is to be placed at the upper elevation, the required hangers are stored in the PARTS STOWAGE compartment on the installer.

c. If installed, unscrew and remove support ring brake handle. Retain brake handle for reinstallation.

d. Remove bolts, washers, and nuts that secure support ring brake to hanger, and remove brake. Retain support ring brake and attaching hardware for reinstallation.

e. Attach a suitable sling to support ring and overhead hoist, and support weight of support ring.

NOTE

The support ring weighs approximately 1,000 pounds.

f. Make sure that weight of support ring is not applied to support ring holders; then remove bolts, washers, and nuts that secure support ring holders to hangers, and remove support ring holders. Retain support ring holders and attaching hardware for reinstallation.

g. Raise or lower support ring clear of installer.

h. Remove existing support ring brake hanger and replace it with alternate brake hanger. Use existing attaching hardware, and torque nuts to 250-330 in-lb.

i. Remove existing support ring holder hangers and replace them with alternate holder hangers. Use existing attaching hardware, and torque nuts to 250-330 in-lb.

j. If short hangers have been installed, finish removing the 3 unused tie rods, and store removed tie rods in PARTS STOWAGE compartment. If long hangers have been installed, install the 3 tie rods. Tie rods are stored in PARTS STOWAGE compartment.

k. Raise or lower support ring as necessary to aline groove in support ring with holder slots in hangers.

l. Install 2 support ring holders. Torque nuts on 3/8-inch-diameter bolts to 70-90 in-lb and nuts on 1/2-inch-diameter bolts to 170-230 in-lb.

m. Move support ring horizontally until contact is made with installed support ring holders. Holding support ring firmly against holders, place third support ring holder in position. If radial bearing on third support ring holder contacts support ring before holder contacts hanger, remove third holder. Disassemble holder, remove one large washer, and reassemble and reinstall holder. Torque center bolt to 10-15 in-lb above drag torque. If interference is not encountered, install third support ring. Torque fasteners to values specified in step l.

n. Install support ring brake. Torque bolts to 400-530 in-lb.

o. Install support ring brake handle.

p. If vertical installer is to be towed, install drawbar and position casters as follows:

(1) Remove drawbar from stowed position (figure 2-4), and secure drawbar with 2 quick-release pins to any one of the 4 sides of vertical installer.

(2) Make sure rear casters are locked in trail position and front casters are unlocked and free to turn. Use spanner wrench to relieve side loads on caster locks so that locks can be moved by hand. Spanner wrench is stored in PARTS STOWAGE compartment.

2-24. LOWERING AND REINSTALLING STAGE-INSTALLED ENGINES.

2-25. The lowering and subsequent reinstalling of stage-installed engines is necessary to effect the removal and installation of certain engine components. Procedures for engine lowering and reinstallation using Engine Vertical Installer G4035 and Components Installers G4071 and G4072 are found in paragraphs 2-26 through 2-33. Procedures that use the engine vertical installer (paragraphs 2-26 and 2-30) are applicable only to engines installed in vertical unstacked stages, whereas procedures that use the component handlers (paragraphs 2-28 and 2-32) are applicable to engines installed in either stacked or vertical unstacked stages.

2-26. LOWERING ENGINE USING ENGINE VERTICAL INSTALLER G4035.

2-27. This procedure is applicable to engines installed in SII and SIVB vertical unstacked stages. An alternate method of performing this task using Components Installers G4071 and G4072 is provided in paragraph 2-28.

a. Lower engine the distance required to effect desired component removal in accordance with engine removal procedures in R-3825-1B. Disconnecting the following engine-to-stage interfaces is not required if the following requirements are met:

(1) Fluid and electrical interface lines need not be disconnected, except on SII-stage center engine, if engine is not lowered more

than 4 inches. On SII-stage center engine, disconnect all clamps and straps that secure fluid and electrical interface lines to stage and disconnect LOX BLEED LINE, OXIDIZER TANK PRESSURIZATION, *FUEL BLEED LINE*, and HYDROGEN TANK PRESSURIZATION lines from stage. Support disconnected lines and protect all lines from abrasion by applying cushioning material between lines and structures that lines may contact.

(2) Fuel and oxidizer inlet ducts need not be disconnected if screw jacks on vertical installers incorporating MD4 change are used to lower the engine, if engine is not lowered more than 3.75 inches, and if engine is not subjected to lateral or rotational movements exceeding 0.375 inch and one degree, respectively.

2-28. LOWERING ENGINE USING COMPONENTS INSTALLER G4071 OR G4072.

2-29. This procedure is applicable to engines installed in SII and SIVB stacked or vertical unstacked stages. An alternate method of performing this task using the Engine Vertical Installer G4035 in unstacked stages only is provided in paragraph 2-26.

a. Make sure lowering system is installed. (Refer to section V.)

b. Obtain the following:

(1) Fluid level, 4-6 inches long

(2) Four 1/2- to 5/8-inch-diameter ropes. (Ropes must be long enough to reach from thrust chamber exit flange to some permanent structure capable of absorbing a minimum of 200-pound side loads. Structures to be attached to must be a minimum of 6 feet from perimeter of thrust chamber exit flange.)

(3) Four 1/4-inch shackles

c. If engine is to be lowered more than 4 inches, disconnect fluid and electrical interface lines and install interface supports. (Refer to R-3825-1B.)

d. If fluid and electrical interface supports are not installed (step c) and engine to be lowered is SII-stage center engine, disconnect from stage, and support LOX BLEED LINE, OXIDIZER TANK PRESSURIZATION, FUEL BLEED LINE, and HYDROGEN TANK PRESSURIZATION lines. In addition, disconnect all clamps and straps that secure fluid and electrical interface lines to stage. Protect interface lines from abrasion by applying cushioning material between lines and structures that lines may contact.

e. Make sure that engine is level in plane controlled by turnbuckles and that turnbuckles are manually tightened (no slack). Use fluid level on oxidizer dome or on dome bolts to check level of engine.

CAUTION

After gimbal-to-stage hardware is loosened and while the weight of the engine is supported by the turnbuckles, the adjustments at the lower end of the turnbuckles must not be changed. Changing lower-end adjustments can induce moments into the turnbuckles that can bend the turnbuckles.

f. Adjust lower end of turnbuckles to dimension shown in figure 2-5; then loosen hardware that secures gimbal to stage, and back off nuts 1/2 ±1/16 inch.

g. Slowly lower engine by extending turnbuckles until a 1/4 ±1/16 inch gap exists between stage and gimbal. Rotate turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other.

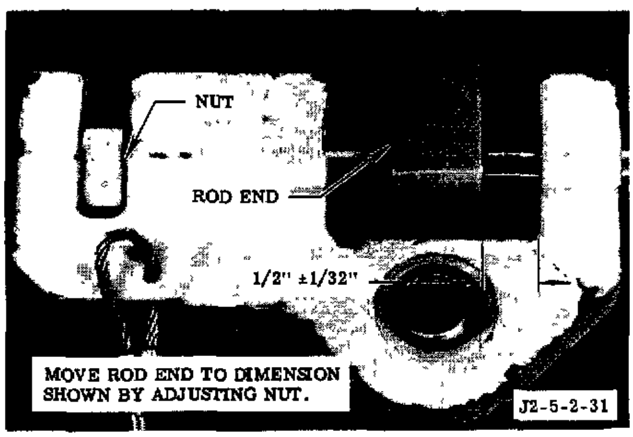


Figure 2-5. Required Turnbuckle Position for Engine Lowering

h. Using ropes and shackles, assemble and attach a bridle to thrust chamber exit flange. Install and adjust bridle to the following requirements:

(1) Ropes must be attached to the exit flange with 1/4-inch shackles at 90-degree intervals and in line with the engine x- and z-axes.

(2) The ropes must be secured to some permanent structure capable of absorbing a minimum of 200-pound side loads and located a minimum of 6 feet from the perimeter of the engine exit flange. Ropes, when secured, must be within 10 degrees of horizontal.

(3) The 2 ropes in line with the engine x-axis must be adjusted and tightened to hold the engine level on the x-axis, with a minimum tension of 25 pounds on the ropes.

(4) The 2 ropes in line with the engine z-axis must be tightened equally to a minimum tension of 25 pounds.

i. Make sure turnbuckles are vertical (vertical in 2 planes, 90 degrees apart). If necessary, return them to vertical by adjusting mechanism at top of turnbuckles.

j. Remove nuts and bolts that formerly secured gimbal to stage.

NOTE

There will be some small side movement at the gimbal, the effect of which can be minimized by lowering slowly and carefully.

k. Slowly lower engine by rotating turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other until just prior to disengagement of gimbal keyway; at this time reduce rotation of turnbuckles to 1/6-turn increments until gimbal is clear. Monitor gimbal while lowering, for evidence of binding or cocking. Correct binding or cocking by straightening gimbal by hand or by pushing on engine around dome area.

l. Lower engine by extending turnbuckles. While lowering, keep engine reasonably level by maintaining turnbuckles within one turn of each other; monitor fluid and electrical interface lines for clearance, and if connected, make sure lines do not become taut. If engine is to be lowered more than 4 inches, make sure fluid and electrical interface lines are disconnected and supported (refer to step c).

NOTE

One flat of the turnbuckle adjusting barrel may be marked as an index to keep count of turnbuckle rotations.

2-30. REINSTALLING LOWERED ENGINE USING ENGINE VERTICAL INSTALLER G4035.

2-31. This procedure is applicable to engines that were lowered using Engine Vertical Installer G4035. (Refer to paragraph 2-27.) If the engine was lowered using Components Installers G4071 or G4072, refer to paragraph 2-32.

a. Verify that alinement of each inlet duct is satisfactory by checking that total misalinement of all 3 sets of index marks on each duct does not exceed 0.066 inch. If ducts do not meet alinement requirement, aline ducts. (Refer to R-3825-1B.)

b. If screw jacks on vertical installers incorporating MD4 change are to be used to raise engine, use Stage Contractor procedures whenever this procedure requires preparation of installer or raising engine.

c. Make sure an external ground cable is connected from vertical installer frame to facility ground. Make sure paint does not insulate connections.

d. Make sure installer is connected to 440-vac, 3-phase, 60-cps electrical power supply with equipment grounding provisions.

e. Make sure facility power is on. POWER ON light on installer control station will be on.

f. Remove any restraints that tether engine.

NOTE

If engine is within 6 inches of its installed position, omit steps g and h.

g. Make sure equal tension is applied to both cables of vertical installer. If tension is unequal, move selector switch to INDIVIDUAL and actuate applicable button to equalize tension.

CAUTION

For lifts of 3 feet or less, hoist must be operated on slow speed. For lifts over 3 feet, hoist may be operated on fast speed until a distance of 3 feet from gimbal mating is reached. At this point, speed must be reduced, since damage to the engine can occur.

h. Position selector switch to DUAL; then actuate DUAL CONTROL ENGINE UP button, and raise engine to within 6 inches of gimbal mating position.

NOTE

The hoists operate at slow speed when the remote-control button is depressed halfway and at fast speed when fully depressed.

i. If inlet ducts were disconnected, remove protective closures from oxidizer and fuel inlet ducts and their mating ports, and install seals.

j. Position selector switch to DUAL; then actuate DUAL CONTROL ENGINE UP button at slow speed until engine gimbal is 1/8 to 3/8 inch from gimbal mating.

k. Position selector switch to OFF.

l. Inspect gimbal for alinement and interface connections for clearance. If gimbal is not alined, adjust gimbal alinement bolts on cable termination blocks, as required. (See figure 2-6.)

m. Raise engine using vertical adjusting screws on cable termination blocks until gimbal keys are mated and engaged approximately 1/8 inch.

n. Install and torque gimbal bolts using Stage Contractor procedures.

o. If inlet ducts were disconnected, aline inlet ducts and seals with interface mating connections, decompress ducts, and remove handlers. Secure inlet duct mating flanges using Stage Contractor procedures.

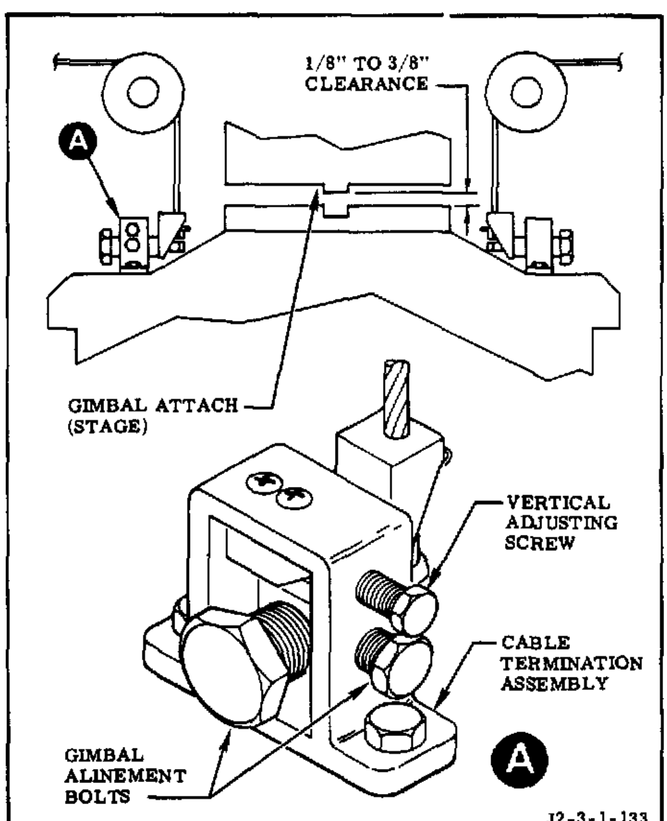


Figure 2-6. Gimbal to Stage Installation Alinement

p. On engines not incorporating MD287 change, install seal on vent port check valve and reinstall valve. Torque valve to 175-200 in-lb and safetywire.

q. If screw jacks on vertical installers incorporating MD4 change were used to raise engine, use Stage Contractor procedures to lower installer to transporting position; then proceed to step u of this procedure.

r. Position selector switch to DUAL. Slack off cables by actuating DUAL CONTROL ENGINE DOWN button. Remove cable termination plugs from cable termination assemblies.

NOTE

DUAL or INDIVIDUAL controls may be used to reel in the cables.

s. Remove cables from overhead pulleys and, wearing heavy gloves, reel in cables.

t. Remove termination assemblies and attach brackets from engine and store them in appropriate compartments.

u. If disconnected, connect interface electrical cables and remove electrical interface support. (Refer to R-3825-1B.)

v. If disconnected, connect fluid interface lines and remove fluid line interface support. (Refer to R-3825-1B.)

w. Connect gimbal actuators. (Refer to R-3825-1B.)

x. Deenergize facility power to vertical installer. MAIN POWER ON light on installer control station will go off.

y. Store control station in storage compartment.

z. Remove installer from installation area. Using spanner wrench 9021031, rotate casters to trail position.

2-32. REINSTALLING LOWERED ENGINE USING COMPONENTS INSTALLER G4071 OR G4072.

2-33. This procedure is applicable to engines that were lowered using Components Installer G4071 or G4072. (Refer to paragraph 2-29.)

a. Raise engine by shortening turnbuckles until gimbal is about to engage stage. Keep engine reasonably level while raising, by maintaining rotation of turnbuckles within one turn of each other.

b. Check that gimbal lines with stage. If misalinement exists that can be compensated for by pushing on engine about the dome area, correct it by hand pressure. If, however, misalinement exists that cannot be corrected by hand pressure, level engine and/or aline gimbal to stage by one or more of the following methods:

(1) Level engine by adjusting length of turnbuckles and/or changing horizontal load at engine exit flange.

(2) If engine is level and gimbal does not aline, move engine in direction to aline gimbal to stage by use of adjustment mechanism at top of turnbuckles. Adjust each side equally so that turnbuckles remain parallel to each other.

c. With gimbal alined, raise engine with 1/6-turn increments on turnbuckles until both keyways are engaged.

d. Continue raising engine by shortening turnbuckles until gimbal is fully engaged (less than 0.030-inch gap) with stage. To aid in prevention of binding between gimbal and stage, keep rotation of turnbuckles within one turn of each other.

e. Secure gimbal to stage, using Stage Contractor procedures.

f. If disconnected, connect interface electrical cables and remove electrical interface support. (Refer to R-3825-1B.)

g. If disconnected, connect fluid interface lines and remove fluid line interface support. (Refer to R-3825-1B.)

h. Remove rope bridle from thrust chamber exit flange.

SECTION III

COMPONENT REMOVAL AND INSTALLATION

WARNING

THE FOLLOWING GROUND SUPPORT EQUIPMENT MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

G3127, Single Head Special Tool Kit
G3128, Automatic Inert Gas Arc Welding Set
G4046, Turbopump Sling
G4063, Oxidizer and Fuel Turbopump Rotating Sling
G4064, Engine Handler
G4071, Engine Component Installer
G4072, Engine Component Installer
9016723-11, Test Plate Kit
9016779, Component Handler Universal Lifting Sling
9016780, Fuel Turbine Exhaust Duct Lifting Sling
9016783-11, Start Tank Installer
9016784, Fuel Inlet Duct Handler
9016785-11, Oxidizer Inlet Duct Handler
9016786, Oxidizer Feed System Handler
9016787, Fuel Feed System Handler
9016789, Sequence Controller Handler
9016790-11, Oxidizer Heat Exchanger Handler
9019968, Heat Exchanger Oxidizer Supply Line Test Plate Kit
9020269, Bypass Valve Removal Tool Kit
9020628, Fluid Lines Interface Support
9022985, Start Tank Sling
9024460, Electrical Interface Support
9024994, Tool Kit
9024999, Pressure Transducer Removal Tool Kit
9025150, Inlet Duct Support Frame Installing Tool Kit
9025425-11, Spark Igniter Cable Pressurization Tool Kit
9025425-21, Spark Igniter Cable Pressurization Tool Kit
9026251, Engine Components Installer Set
9026252, Engine Components Installer Set

3-1. SCOPE. This section contains component removal and installation procedures for engines installed on Engine Handler G4064 and in vertical unstacked and stacked stages.

3-2. GENERAL INFORMATION.

3-3. Procedures for specific engine environments (engines installed in handlers, unstacked stages, etc) and procedures that have an effect on engine alinement or calibration have appropriate statements to that effect in the procedure title and opening paragraphs. Procedures for engines installed in stacked stages are based on the assumption that stage work decks and, where applicable, heat shields and heat shield protective pads are installed, and capability for transporting GSE into the stage and adequate lighting for component removal and installation is provided. An early step in each removal procedure (stacked stages), is to assemble the GSE necessary to handle the component. Performance of this task at this time is not mandatory but may, at the discretion of the using personnel, be performed at any point prior to the procedural requirement to attach the handling equipment to the component. Similarly, installation procedures (stacked stages), contain a step to disassemble and remove the GSE when no longer required. Performance of this step in sequence is optional and may be delayed, if desired, until the component installation is complete and the component tested. No requirement to assemble the handling GSE is made in the installation procedures, since it is assumed that equipment required to remove the component will remain assembled for component reinstallation.

Figure 3-1 deleted.

3-4. ARMORED HARNESS.

3-5. REMOVING ARMORED HARNESS.

a. While performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect armored harness electrical connectors (paragraph 3-30).

c. Remove harness support and bonding clamps and remove harness from engine without damaging harness or other engine components.

d. Torque closures to same torque values indicated in figure 3-9 for torquing plugs to receptacles.

3-6. INSTALLING ARMORED HARNESS.

a. If armored harness is being replaced, verify that armored harness preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain a milliohmmeter No. 370-A (Shallcross Mfg Co) or equivalent.

b. While performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Position armored harness on engine, routing various branches to respective connect points. (Refer to R-3825-4 for routing of armored harness.)

d. Apply a light coat of FS1281 grease (Dow Corning Corp) to inside of thermal protecting boot. Slide boot over electrical connector onto cable.

e. Connect electrical connectors (paragraph 3-31).

f. Remove all dirt, grease, and foreign particles from all bonding surfaces.

g. Install harness support and bonding clamps, starting with clamp near center of harness and working toward connector at each end. (Refer to section I for electrical harness support clamp installation requirements.) Make sure no excess strain is applied to harness or connectors.

h. Torque support and bonding clamp screws to 24-30 in-lb.

i. If electrical cable touches accumulator hose (hose from helium regulator to primary flight instrumentation package), apply 2 layers of tape 602 (Moxness Products, Inc) or tape 2650 (Johnson and Johnson, Inc) to electrical cable in area where hose and cable touch.

NOTE

It is permissible for the accumulator hose to touch the taped portion of the electrical cable.

j. Using milliohmmeter check bonding resistance between armor braid of each armored cable and component it is bonded to. Bonding resistance must not exceed 100 milliohms.

k. Refer to section IV for test requirements.

3-7. AUGMENTED SPARK IGNITER.

3-8. REMOVING AUGMENTED SPARK IGNITER (ENGINES INCORPORATING MD256 OR MD267 CHANGE BUT NOT INCORPORATING MD327, MD328, MD329, MD332, OR MD344 CHANGE). (See figure 3-2.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. While performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove gimbal (paragraph 3-111.)

c. Remove SIC pressurizing valve caps.

d. Measure pressure in SIC as outlined in R-3825-1B. There is no requirement at this time to perform any corrective action required by R-3825-1B.

e. Depressurize SIC by backing off pressurizing valve swivel nuts (using crowfoot wrench 9019552 from toolkit 9025425-21) 1/2 to 1 turn and depressing valve cores.

f. Remove the 4 pressurizing valves (paragraph 3-245B).

g. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG SIC, and remove bracket.

CAUTION

Care must be taken throughout this procedure to prevent damage to the SIC pressurizing lines.

h. Remove remaining bolts and washers that attach GG SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

i. Remove GG SIC bell housing from ECA by pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

iA. Visually inspect GG SIC insulator and ECA exicter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

CAUTION

Failure to counter frictional forces generated by removing the grommet can dislodge the bushing from the antirotation ring in SIC NA5-27448. A dislodged bushing can prevent pressurization of the SIC.

iB. On SIC NA5-27448 or NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet. On SIC NA5-27448, maintain finger pressure against insulator while removing grommet.

j. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

jA. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support ST3950166RKL001 on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

jB. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

jC. Install clean protective closures (paragraph 3-258) on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

k. Disconnect electrical connectors (paragraph 3-30) P1, P2, and P3.

l. Remove ASI SIC pressurizing tube support clamps, except do not remove clamps that clamp pressurized line to SIC.

m. Remove bolts and washers that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.

- Excessive bending and twisting of SIC can damage the cable bellows.

n. Remove ASI SIC bell housing from ECA by pulling straight out until insulator clears exciter output adapter. Use care to prevent damage to SIC and ECA.

nA. Visually inspect ASI SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

nB. If it is expected that more than 7 days will elapse before reinstallation, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas on ECA where protective finish has been removed.

nC. On SIC NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet.

o. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

CAUTION

Incorrect installation of desiccant can displace desiccant retainer, causing damage to the SIC connector.

oA. Make sure'SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

oB. Install clean protective closures (paragraph 3-258) on ASI SIC bell housing and ECA.

p. Remove SIC support clamps. Note position of clamps for reinstallation.

q. Remove ignition detector probe (paragraph 3-152).

r. Cut lockwire, and remove bolts and washers that secure fuel probe hose to ASI fuel manifold. Remove seal, and protect open ports and sealing surfaces.

s. Cut lockwire, and remove bolts and washers that secure fuel manifold to thrust chamber.

t. Remove ASI oxidizer line phenolic block clamps.

u. Remove bolts that secure ASI oxidizer line and seal to ASI valve; then remove seal, and protect open ports and sealing surfaces.

v. (Deleted)

CAUTION

Removing the ASI without cleaning dirt and foreign matter from around the ASI injector can result in contamination of thrust chamber injector.

w. Clean all dirt and foreign matter from around ASI injector.

x. Cut lockwire, and remove bolts and washers that secure ASI injector to thrust chamber oxidizer injector dome. Remove ASI and seal. Install clean protective closures (paragraph 3-258) on ASI and thrust chamber oxidizer dome.

y. Remove protective material that was installed to protect line, manifold, and valve sealing flange during this procedure, and install clean protective closures (paragraph 3-258).

3-9. REMOVING AUGMENTED SPARK IGNITER (ENGINES INCORPORATING MD327, MD328, MD329, MD332, OR MD344 CHANGE). (See figure 3-2.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. While performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove gimbal (paragraph 3-111).

c. Remove SIC pressurizing valve caps.

d. Measure pressure in SIC as outlined in R-3825-1B. There is no requirement at this time to perform any corrective action required by R-3825-1B.

e. Depressurize SIC by backing off pressurizing valve swivel nuts (using crowfoot wrench 9019552 from toolkit 9025425-21) 1/2 to 1 turn and depressing valve cores.

f. Remove the 4 pressurizing valves (paragraph 3-245B).

g. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG SIC, and remove bracket.

CAUTION

> Care must be taken throughout this procedure to prevent damage to the SIC pressurizing lines.

h. Remove remaining bolts and washers that attach GG SIC to ECA.

CAUTION

> Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

i. Remove GG SIC bell housing from ECA by pulling straight out until insulator clears exciter output adapter. Use care to prevent damage to SIC and ECA.

iA. Visually inspect GG SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

CAUTION

> Failure to counter frictional forces generated by removing the grommet can dislodge the bushing from the antirotation ring in SIC NA5-27448. A dislodged bushing can prevent pressurization of the SIC.

iB. On SIC NA5-27448 or NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet. On SIC NA5-27448, maintain finger pressure against insulator while removing grommet.

iC. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

iD. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support ST3950166RKL001 on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

> Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

iE. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

j. Install clean protective closure (paragraph 3-258) on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

k. Disconnect electrical connectors (paragraph 3-30) P1, P2, and P3.

l. Remove ASI SIC pressurizing line support clamps, except do not remove clamps that clamp pressurizing lines to SIC.

m. Remove bolts and washers that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.

n. Remove ASI SIC bell housing from ECA by pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

nA. Visually inspect ASI SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

nB. If it is expected that more than 7 days will elapse before reinstallation, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas on ECA where protective finish has been removed.

nC. On SIC NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet.

nD. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

nE. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

o. Install clean protective closures (paragraph 3-258) on ASI SIC bell housing and ECA.

CAUTION

While heating the splice, care must be taken to prevent overheating or burning the adjacent components.

p. Carefully heat line splice (sleeves), and remove SIC pressurizing bosses, lines, and sleeves from stub-out line on SIC bell housing. Protect open ends of lines.

q. Remove SIC support clamps. Note position of clamps for reinstallation.

r. Remove ignition detector probe (paragraph 3-152).

s. Cut lockwire, and remove bolts and washers that secure ASI fuel line to lower fuel line flange. Remove seal, and protect open ports and sealing surfaces.

t. Remove nuts, screws, washers, shims, and blocks that secure ASI oxidizer line to the 2 support brackets. Note position of blocks and shims for reinstallation.

u. Cut lockwire, and remove bolts and washers that secure ASI oxidizer line to ASI valve. Remove seal, and protect open ports and sealing surfaces.

CAUTION

Removing the ASI without cleaning dirt and foreign matter from around the ASI injector can result in contamination of the thrust chamber injector.

v. Clean all dirt and foreign matter from around ASI injector.

w. Cut lockwire, and remove bolts and washers that secure ASI injector to thrust chamber oxidizer dome. Remove ASI and seal. Install clean protective closures (paragraph 3-258) on ASI injector and thrust chamber oxidizer dome.

x. Remove protective material that was installed to protect ASI lines and valve sealing flanges during this procedure, and install clean protective closures (paragraph 3-258).

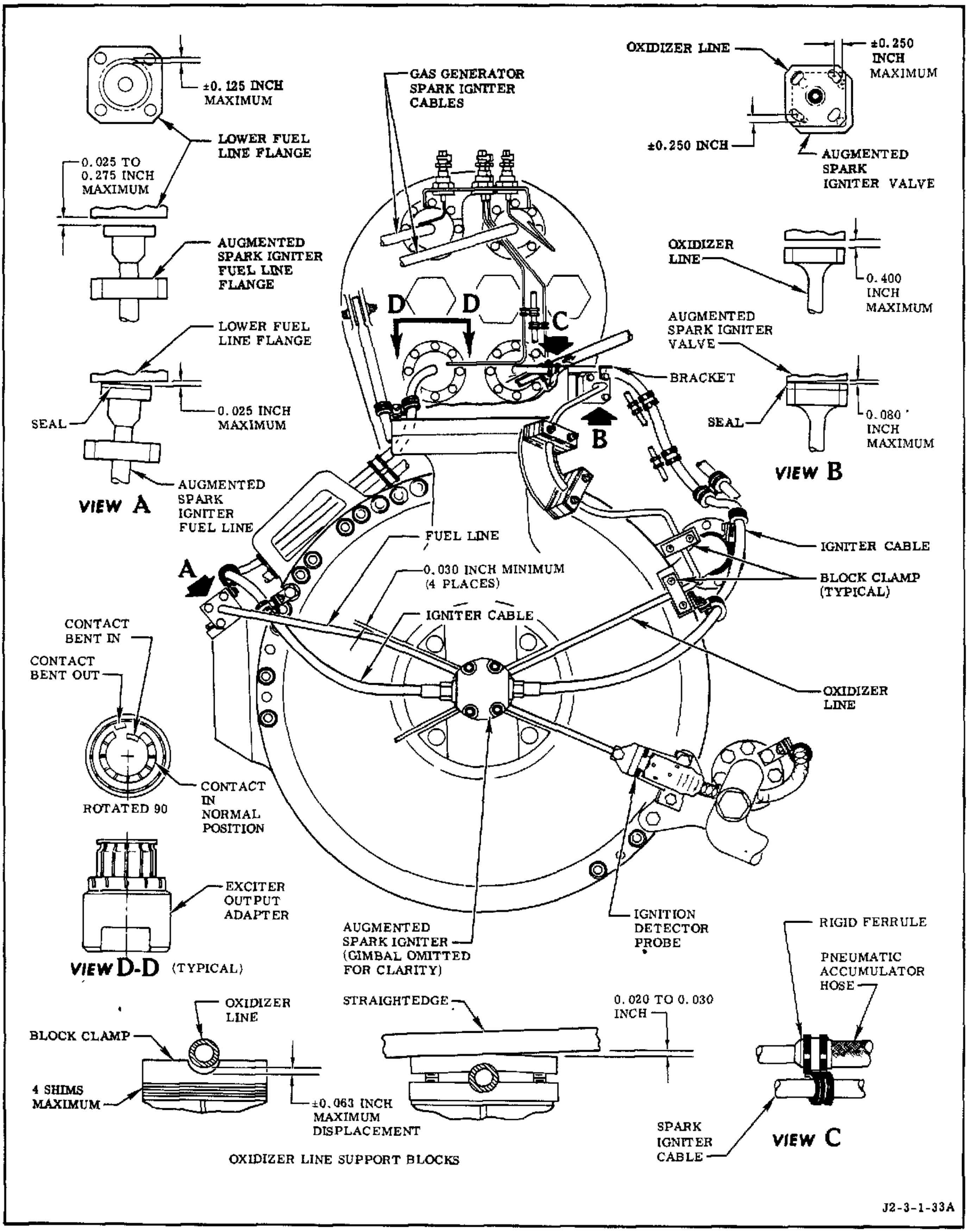


Figure 3-2. Augmented Spark Igniter

3-10. INSTALLING AUGMENTED SPARK IGNITER (ENGINES INCORPORATING MD327, MD328, MD329, MD332, OR MD344 CHANGE). (See figure 3-2.)

a. Obtain a milliohmmeter No. 370-A (Shallcross Mfg Co) or equivalent.

b. While performing this procedure, observe safety precautions and contamination and damage requirements in section I.

CAUTION

- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

c. Remove protective closures (paragraph 3-257) from ASI, lower fuel line, ASI valve port, and thrust chamber injector dome.

cA. Visually inspect ASI SIC insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found on cable insulator, replace insulator (R-3825-3, Volume II).

d. Make sure ASI, lower fuel line flange, ASI valve flange, and thrust chamber injector dome flange are clean and free of damage, and make sure ASI is ok to install. Visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to section I.)

e. Protect the following line and valve flange open ports and sealing surfaces:

(1) ASI oxidizer line flange.

(2) ASI fuel line flange.

(3) Lower fuel line flange.

(4) ASI valve flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

eA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

f. Reinstall clean protective closures (paragraph 3-258) on ASI SIC and all other ports on ASI (except ASI injector and thrust chamber injector dome closures).

g. Route ASI SIC to ECA.

h. Install ASI on thrust chamber injector dome as follows:

(1) Place ASI on thrust chamber injector dome without seal.

(2) Install bolts, and rotate ASI clockwise against bolts. Torque bolts to 15-20 in-lb.

(3) Place a straightedge bar across thrust chamber injector dome gimbal mounting surfaces.

(4) Mark place where straightedge bar is placed and center of top surface of ASI valve.

NOTE

To make sure correct measurements are obtained, measurements must be taken from the same place.

(5) Measure and record clearance between top surface of ASI and straightedge.

(6) Loosen bolts, and rotate ASI counterclockwise against bolts. Torque bolts to 15-20 in-lb; then measure and record clearance.

(7) Remove bolts, carefully raise ASI, and install seal. Lower ASI into place.

(8) Install bolts, and rotate ASI clockwise against bolts. Torque bolts to 15-20 in-lb.

(9) Place straightedge on marks (substep 4). Measure and record clearance.

(10) Loosen bolts, and rotate ASI counterclockwise against bolts. Torque bolts to 15-20 in-lb; then measure and record clearance.

(11) Calculate difference between measurements recorded in substeps 5 and 9 and difference between measurements recorded in substeps 6 and 10. Difference must be a minimum of 0.018 inch. If difference is less than 0.018 inch, contact Rocketdyne representative for disposition.

i. Install seal and ASI injector to thrust chamber injector dome with bolts and washers. Tighten bolts fingertight. Washers LD153-0010-0011 must be installed between ASI and washers LD153-0013-0002.

j. Aline ASI on thrust chamber dome. Clearance between ASI and dome must be 0.030 inch minimum. (See figure 3-2.)

NOTE

This alinement positions the ASI oxidizer and fuel lines so that a minimum of alinement is required to aline the flanges after torquing the ASI.

k. Torque ASI bolts to 66-74 in-lb and safetywire.

l. Remove protective material from ASI oxidizer line and ASI valve.

m. Install seal between ASI oxidizer line flange and ASI valve.

n. Perform an oxidizer line and flange alinement check as follows: (See figure 3-2.)

(1) Mating holes in flange of oxidizer line must aline with mating holes in ASI valve within 0.250 inch.

(2) Measure gap between oxidizer line and mating flange of ASI valve. Gap must not exceed 0.400 inch.

(3) Apply hand pressure to oxidizer line until seal contacts mating surface of ASI valve. Mating surfaces of oxidizer line flange and valve flange must be parallel within 0.080 inch.

(4) Apply hand pressure to oxidizer line until seal contacts mating surface of valve. If bolts can be installed without force, rotational alinement is acceptable.

(5) With block clamps installed on both support brackets, line deflection must not exceed 0.063 inch in either direction from lower point of block clamp cutout. (See figure 3-2.) (A maximum of 4 shims may be used between brackets and block clamps to obtain alinement.)

(6) If distance between oxidizer line and line mating surfaces of block clamps is 1/32 inch or more, install shims (a maximum of 4) between block clamps and support bracket to prevent preloading oxidizer line.

CAUTION

The oxidizer line must be supported to prevent excessive loads on the weld near the ASI injector when making alinement bends.

o. If ASI oxidizer line does not fall within tolerances outlined in step n, bend oxidizer line to meet requirements. Use an approved tube-bending tool, and support the oxidizer line to prevent movement during alinement bending. Bends must not be made within 3 inches of any tube weld.

p. Install seal, bolts, and washers that secure ASI oxidizer line to ASI valve. Torque bolts to 41-45 in-lb and safetywire.

q. Install block clamps and shims that support ASI oxidizer line as follows:

(1) All shims not required under block clamp must be used on top of upper block clamp because of screw length.

(2) Secure clamps and shims to support bracket with screws, washers, and nuts. Torque screws evenly to maintain equal spacing between upper and lower clamps. Torque screws until clamp has a 0.020 to 0.030 inch deflection as determined with straightedge and vernier calipers (see figure 3-2), or torque screws to 12-15 in-lb above running torque of locking device, whichever occurs first.

r. Remove protective material from flanges of ASI fuel line and lower fuel line.

s. Install seal between ASI fuel line and lower fuel line.

t. Perform a fuel line flange alinement check as follows: (See figure 3-2.)

(1) Mating holes in ASI fuel line flange must aline with holes in lower fuel line flange within ±0.125 inch.

(2) Measure gap between ASI fuel line and lower fuel line flange. Gap must be within 0.025 to 0.275 inch.

(3) Apply hand pressure to ASI fuel line flange until seal contacts mating surface of lower fuel line flange. Mating surfaces must be parallel within 0.025 inch.

(4) Apply hand pressure to ASI fuel line flange until seal contacts mating surface of lower fuel line flange. If all bolts can be installed without forcing, rotational alinement is acceptable.

CAUTION

The fuel line must be supported to prevent excessive loads on the weld near the ASI injector when making alinement bends.

u. If fuel line does not fall within tolerances of step t, bend fuel line to meet alinement requirements. Use an approved tube-bending tool, and support fuel line to prevent movement during alinement bending. Bends must not be made within 3 inches of any tube weld.

v. Install seal, bolts, and washers that secure ASI fuel line to lower fuel line. Torque bolts to 80 ±4 in-lb and safetywire.

w. As closures are removed from ECA, visually inspect ECA exciter ceramic insulators for a breakdown path (sharply defined black or dark gray line), damaged threads in parent metal and/or threaded inserts for damage and correct installation (section I). If a breakdown path is found on an ECA exciter insulator, replace ECA (paragraph 3-32).

x. Remove protective closures (paragraph 3-257), from SIC bell housing, and exciter output adapter, only as each cable is installed.

y. Using a small wire brush or 320-grit (or finer) abrasive cloth or paper, remove protective finishes from bonding surface of 4 SIC attaching bolts and bonding surface around 4 boltholes, approximately 90 degrees apart, on each SIC bell housing. Take care not to damage sealing surfaces.

WARNING

The following procedure uses trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

z. Clean bonding and mating surfaces of SIC bell housing, ECA, and bell housing attaching bolts with a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602).

CAUTION

Care must be taken during the brazing process to prevent overheating or burning the adjacent components.

aa. Purge pressurizing line in SIC bell housing and line on pressurizing valve boss with gaseous nitrogen (MIL-P-27401) to remove any chips or foreign matter.

ab. Braze pressurizing line in SIC bell housing to line on pressurizing valve boss, using a sleeve, gold-silver-copper-zinc brazing alloy RB0170-089 (Rocketdyne), and flux mixture of 50 percent Handy flux and 50 percent Handy flux, Type B1 (Handy and Harman).

NOTE

When an ASI is being replaced, it may be necessary to reshape the pressurizing boss line due to the location of the SIC pressurizing line.

ac. Apply a low-pressure purge to pressurizing line after brazing, to make sure brazing did not block line.

ad. Inspect each ASI cable exciter output adapter for bent or broken contacts as follows: (See figure 3-2.)

(1) Contacts bent less than 0.070 inch from normal position are acceptable. Do not straighten.

(2) Contacts bent 0.070 inch or more from normal position must be broken off (bend contact back and forth) and discarded.

(3) Adapters that have no more than two broken contacts are acceptable.

(4) If adapters have more than two broken contacts, replace ECA.

ae. Lubricate (Method A, section I) bolts that attach ASI cable to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

af. Lubricate (Method J, section I) ASI cable O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

ag. Install each ASI SIC on ECA as follows:

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

(1) On SIC NA5-27448T1, wearing clean nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

(2) Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of output adapter fingers.

(3) Center SIC insulator over exciter output adapter with pressurizing line boss positioned between exciter output adapters G3 and G4, and press bell housing down so that insulator goes straight into exciter output adapter.

(4) Install bolts, with washers, in igniter cable bell housing. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding. Cross-torque bolts that secure ASI SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb. Safetywire bolts.

ah. (Deleted)

ai. To minimize the possibility of the need to disassemble due to ASI SIC leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for leak-test procedures.)

aj. Remove protective closures (paragraph 3-257), and install electrical connectors (paragraph 3-31) P1, P2, and P3.

ak. Inspect each GG SIC exciter output adapter for bent or broken contacts as follows: (See figure 3-2.)

(1) Contacts bent less than 0.070 inch from normal position are acceptable. Do not straighten.

(2) Contacts bent 0.070 inch or more from normal position must be broken off (bend contact back and forth) and discarded.

(3) Adapters that have no more than two broken contacts are acceptable.

(4) If adapters have more than two broken contacts, replace ECA.

al. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

am. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

an. Install each GG SIC on ECA as follows:

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

(1) Wearing clean, nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of output adapter fingers.

(2) Center SIC insulator over exciter output adapter with pressurizing line alined with pressurizing lines from bell housings G1 and G2, and press bell housing down so that insulator goes straight into exciter output adapter.

(3) Install 2 bolts, with washers, fingertight into holes that are in line with centers of bell housings G3 and G4. If these holes are cleaned for bonding, make sure bolts cleaned for bonding are used.

ao. Position bracket on SIC pressurizing line bosses, and secure bracket and SIC bell housing to ECA with bolts. Tighten bolts fingertight. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding.

ap. Install remaining bolts, with washers, in SIC bell housing. Make sure bolts cleaned for bonding are installed in holes that have surrounding area cleaned for bonding. Tighten bolts fingertight.

aq. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb. Safetywire bolts.

ar. Lubricate (Method A, section I) exterior threads of pressurizing bosses with lubricant grease RB0140-012 (Rocketdyne), and install washers and nuts on pressurizing bosses. Torque nuts to 290 ±10 in-lb and safetywire.

as. Install the 4 pressurizing valves (paragraph 3-245C).

at. Using milliohmmeter, measure resistance between ECA and thrust chamber. Resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded junctures if thrust chamber or ECA structure is suspect for excessive resistance.

au. Using milliohmmeter, measure resistance between any one of the 4 bonded bolts that secure each ASI cable bell housing to ECA. Resistance must not exceed 10 milliohms. Measurement may be made as close as possible to bonded junctures if bolt or ECA structure is suspect for excessive resistance. Complete step av within 24 hours of completion of resistance checks (steps at and au); otherwise repeat steps at and au.

av. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonded areas.

aw. Install SIC support clamps as follows: (See figure 3-2.)

NOTE

SIC support clamps may vary in size from cable to cable and from one location to another on the same cable, depending on the thickness of the cable protective covering (armor braid and heat-shrinkable or tape-wrapped ablative covering).

(1) Install clamps that will support the SIC but will not compress or deform SIC protective covering.

(2) Torque screws in support clamps to 24-30 in-lb.

ax. Install clamps that support SIC pressurizing lines to SIC and other support points as noted during removal. Torque screws in support clamps to 24-30 in-lb. Cable bend radii must be 2.00 inches or greater.

ay. Leak-test and pressurize SIC. (Refer to R-3825-1B.)

az. Install ignition detector probe. (Refer to paragraph 3-153.)

ba. Install gimbal (paragraph 3-111).

bb. Refer to section IV for test requirements.

3-11. <u>AUGMENTED SPARK IGNITER LOWER FUEL LINE.</u>

3-12. REMOVING AUGMENTED SPARK IGNITER LOWER FUEL LINE (ENGINES INCORPORATING MD327, MD328, MD329, MD332, OR MD344 CHANGE). (See figure 3-3.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. On engines incorporating MD331 change, or incorporating MD344 change but not incorporating MD347 change, loosen (do not remove) bolts that attach start tank liquid refill line flange to lower fuel line.

c. Loosen (do not remove) bolts that attach lower fuel line to ASI fuel line.

d. Remove screws, blocks, clamps, spacers, washers, and shims that attach lower fuel line to thrust chamber. Note position of shims for reinstallation.

e. Remove bolts, washers, and seals from connecting flanges, and protect open ports and sealing surfaces. Remove lower fuel line.

f. Remove all protective material from ASI lower fuel line and engine ports, and install clean protective closures (paragraph 3-258).

g. On engines incorporating MD347 change or not incorporating MD331 change, if line is to be replaced, remove plate, bolts, seal, and washers from lower fuel line. Retain plate for installation on new line.

h. Install clean protective closure (paragraph 3-258) on open port.

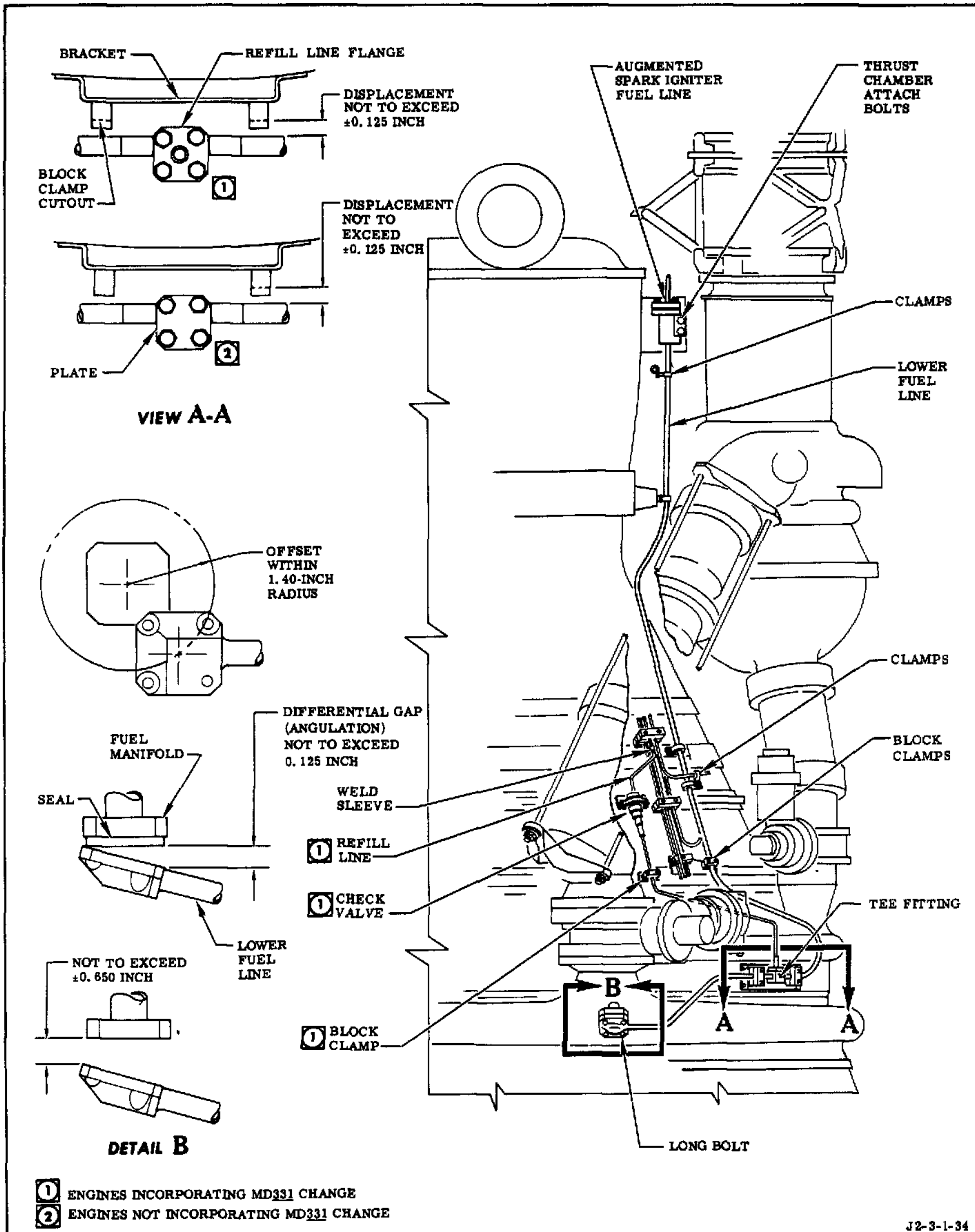


Figure 3-3. Augmented Spark Igniter Lower Fuel Line and Start Tank Refill Line (Engines Incorporating MD327, MD328, MD329, MD332, or MD344 Change)

3-13. INSTALLING AUGMENTED SPARK IGNITER LOWER FUEL LINE (ENGINES INCORPORATING MD327, MD328, MD329, MD332, OR MD344 CHANGE). (See figure 3-3.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure that ASI lower fuel line and mating ports on engine are clean and free of damage, that threads in parent metal and/or threaded inserts are free of damage, and that threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. On engines incorporating MD347 change or not incorporating MD331 change, if lower fuel line is replaced, remove protective covering and install plate (removed from old line) and seal on lower fuel line with bolts and washers. Torque bolts to 52-58 in-lb and safetywire.

d. Position lower fuel line on engine and install bolts that attach lower fuel line to thrust chamber bracket (located at mating flange of ASI fuel line). Tighten bolts fingertight.

e. Temporarily install clamps, shims, washers, screws, and nuts that attach lower fuel line to thrust chamber. Reinstall shims in same position as before removal. Tighten nuts, bolts, and screws fingertight.

f. Remove protective material from ASI fuel line flange and mating flange on lower fuel line. Install seal on ASI fuel line and aline to lower fuel line flange as follows:

NOTE

Shims may be removed or added between blocks and brackets as required to obtain alinement. A maximum of 4 shims can be installed between block and bracket.

(1) Holes in lower fuel line flange must be within 0.125 inch of holes in ASI fuel line flange. (See figure 3-3.)

(2) Gap between ASI fuel line and lower fuel line flange must be 0.025 to 0.275 inch.

(3) With hand pressure applied to ASI fuel line until seal contacts mating surfaces of lower fuel line flange, mating surfaces of flanges must be parallel within 0.025 inch and all bolts must be capable of being installed without force.

g. If alinement is not obtained, hand-form tube using an approved tube bender. Do not make bends within 3 inches of welds.

h. While maintaining alinement, torque lower fuel line mounting bolts to 80 ±4 in-lb and safetywire.

i. Install bolts and washers that attach ASI fuel line flange to lower fuel line. Torque bolts to 80 ±4 in-lb and safetywire.

j. Remove protective covering from lower fuel line flange and mating flange on thrust chamber fuel inlet manifold. The flanges must aline within a 1.40-inch radius, the flanges must be parallel within 0.125 inch, and gap must not exceed ±0.650 inch. (See figure 3-3.)

k. If alinement is not obtained, hand-form tube using an approved tube bender. Do not make bends within 3 inches of welds.

l. When alinement is obtained, install seal, bolts (one bolt is longer than the others), and washers. Torque bolts to 52-58 in-lb and safetywire.

m. Check displacement of lower fuel line at refill tee fitting. Maximum displacement between lower fuel line and blocks (located near either end of tee) must not exceed ±0.125 inch.

n. If displacement exceeds ±0.125 inch, hand-form tube using an approved tube bender. Do not make bends within 3 inches of welds.

o. On engines incorporating MD331 change, or incorporating MD344 change but not incorporating MD347 change, remove protective covering, install seal, and attach refill line. Torque bolts to 52-58 in-lb and safetywire. On engines not incorporating MD331 change, make sure plate is installed. (Refer to step c.)

p. Torque screws that attach blocks, evenly to maintain equal spacing between blocks. Torque screws until block has a 0.020 to 0.030 inch deflection or to 12-15 in-lb above running torque, whichever occurs first. All 4 shims must be used on blocks. Install shims on upper block that are not required between lower block and bracket.

q. Torque nuts that attach lower fuel line clamps to 24-30 in-lb.

r. Torque nut that attaches support to bracket to 75-85 in-lb and nut that attaches clamp to support to 24-32 in-lb.

s. Refer to section IV for test requirements.

3-14. AUGMENTED SPARK IGNITER OXIDIZER LINE.

3-15. REMOVING AUGMENTED SPARK IGNITER OXIDIZER LINE (ENGINES NOT INCORPORATING MD256, MD267, MD278, MD327, MD328, MD329, MD332, OR MD344 CHANGE).

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Loosen (do not remove) 2 bolts that secure ASI oxidizer manifold to bracket.

c. Loosen (do not remove) 2 bolts that secure manifold bracket to thrust chamber bracket.

d. Remove nut, washers, screw, and clamp that secure ASI oxidizer line to bracket.

e. Remove bolts, washers, and bracket that secure oxidizer line to ASI valve; remove seal, and protect open ports and sealing surfaces.

f. Remove bolts and washers that secure oxidizer line to oxidizer manifold; remove oxidizer line, seal, and orifice, and protect open ports and sealing surfaces.

g. Remove all protective material from ASI oxidizer line and engine ports; install clean protective closures (paragraph 3-258).

3-16. AUGMENTED SPARK IGNITER VALVE.

3-17. REMOVING AUGMENTED SPARK IGNITER VALVE. (See figure 3-4.)

a. Obtain an adapter T-5041554.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Disconnect electrical connector (paragraph 3-30) P120.

d. Disconnect calips line from tee on No. 1 mainstage OK pressure switch, and protect open ports and sealing surfaces.

e. Remove bolts and washers that secure purge control valve vent line to purge control valve; then remove seal, and protect open ports and sealing surfaces.

f. Mark location of and remove sufficient clamps from disconnected calips and vent lines to provide access for removal of ASI valve.

g. Record, for reinstallation information, shim location at each of 4 sets of phenolic blocks that support ASI oxidizer line. Remove phenolic blocks and shims. Do not distort oxidizer line.

h. Remove bolts and washers that secure ASI oxidizer line to oxidizer outlet port; then remove seal, and protect open ports and sealing surfaces.

i. Remove bolts, washers, and bracket from flange on opening port; then remove seal, and protect open ports and sealing surfaces.

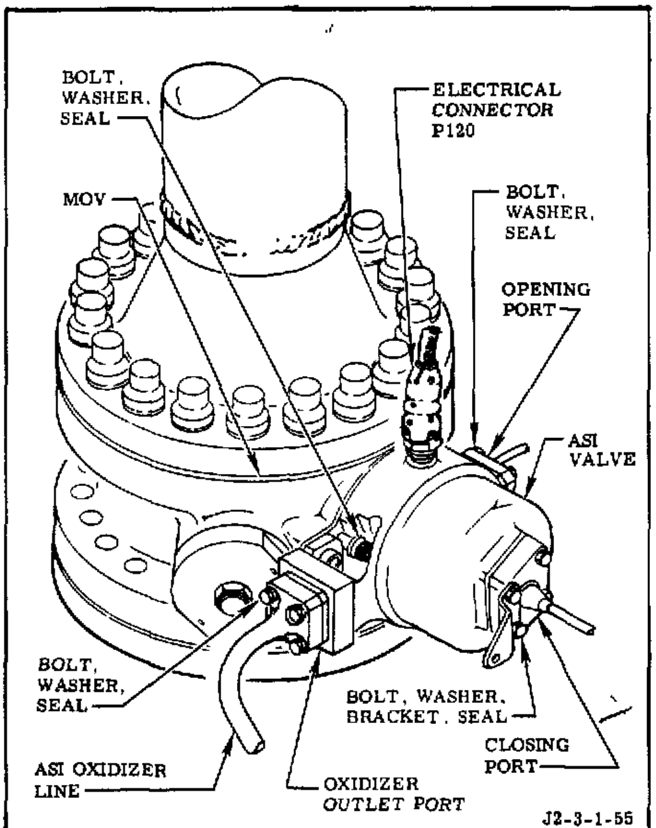


Figure 3-4. Augmented Spark Igniter Valve

j. Remove bolts and washers from flange on closing port; then remove seal, and protect open ports and sealing surfaces.

k. Using adapter T-5041554 (where necessary for access), remove bolts and washers that secure ASI valve to MOV; then remove valve and seal.

l. Remove all protective material from ASI valve and engine ports; then install clean protective closures (paragraph 3-258).

3-18. INSTALLING AUGMENTED SPARK IGNITER VALVE. (See figure 3-4.)

a. Obtain an adapter T-5041554.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure ASI valve, MOV mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Remove protective material from mating surfaces of ASI valve and engine; then install ASI valve with seal on MOV and secure with bolts and washers. Using adapter, cross-torque bolts to 48-52 in-lb and safetywire.

e. Remove protective material from closing port and line; then install seal and secure with bolts and washers. Cross-torque bolts to 41-45 in-lb and safetywire.

f. Perform an ASI oxidizer line and flange alinement check as follows: (See figure 3-2.)

(1) Mating holes in flange of ASI oxidizer line must aline with mating holes in ASI valve within 0.250 inch.

(2) Measure gap between ASI oxidizer line and mating flange of ASI valve. Gap must not exceed 0.400 inch.

(3) Install seal and apply hand pressure to ASI oxidizer line until seal contacts mating surface of ASI valve. Mating surfaces of ASI oxidizer line flange and valve flange must be parallel within 0.080 inch.

(4) Apply hand pressure to ASI oxidizer line until seal contacts mating surface of valve. If bolts can be installed without force, rotational alinement is acceptable.

(5) With block clamps installed on both support brackets, line deflection must not exceed 0.063 inch in either direction from lower point of block clamp cutout. (A maximum of 4 shims may be used between brackets and block clamps to obtain alinement.)

(6) If distance between ASI oxidizer line and line mating surfaces of block clamps is 1/32 inch or more, install shims (a maximum of 4) between block clamps and support bracket to prevent preloading ASI oxidizer line.

CAUTION

The ASI oxidizer line must be supported to prevent excessive loads on the weld near the ASI injector when making alinement bends.

g. If ASI oxidizer line does not fall within tolerances outlined in step f, bend oxidizer line to meet requirements. Use an approved tube-bending tool, and support the ASI oxidizer line to prevent movement during alinement bending. Bends must not be made within 3 inches of any tube weld.

h. Remove protective material from oxidizer outlet port and line; then install seal and secure with bolts and washers. Cross-torque bolts to 41-45 in-lb and safetywire.

i. Install block clamps and shims that support ASI oxidizer line as follows: (See figure 3-2.)

(1) All shims not required under block clamps must be used on top of upper block clamp because of screw length.

(2) Secure clamps and shims to support brackets with screws, washers, and nuts. Torque screws evenly to maintain equal spacing between upper and lower clamps. Torque screws until clamp has a 0.020 to 0.030 inch deflection, or torque screws to 12-15 in-lb above running torque of locking device, whichever occurs first.

j. Remove protective material from pneumatic opening port and line; then install seal and secure with bolts, washers, and bracket. Cross-torque bolts to 41-45 in-lb and safetywire.

k. Remove protective material from purge control valve vent line and purge control valve; then install seal and secure with bolts and washers. Cross-torque bolts to 41-45 in-lb and safetywire.

l. Remove protective material from calips line and tee on No. 1 mainstage OK pressure switch; then connect line to tee. Torque coupling nut to 135-185 in-lb and safetywire.

m. Install clamps at marked locations on purge control valve vent and calips lines. Torque screws to 24-30 in-lb.

n. Connect electrical connector (paragraph 3-31) P120.

o. Refer to section IV for test requirements.

3-19. <u>AUXILIARY FLIGHT INSTRUMENTATION PACKAGE</u>.

3-20. REMOVING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE. (See figure 3-5.) This procedure is for manual removal of the auxiliary FI package. If the specialized component handling equipment for stacked stages is to be used, refer to paragraph 3-21 or 3-22, as applicable.

a. If component is to be removed from engine in an SIVB stacked stage, install access work platform adjacent to auxiliary FI package. (Refer to section V for procedures for installing access work platform.)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove support clamps as required to gain access for removal of auxiliary FI package. Note location and position of clamps for reinstallation.

d. Disconnect and secure electrical connectors (paragraph 3-30) P150, P151, and P152.

e. Cut instrumentation lines to auxiliary FI package, and protect opened lines. (Refer to section VI for tube-cutting requirements.)

f. Support auxiliary FI package (approximately 30 pounds), disconnect ground cable from thrust chamber bracket, and remove nuts, washers, bolts, and spacer that attaches FI package to thrust chamber and strut.

g. Remove auxiliary FI package.

h. If it is expected that more than 7 days will elapse before reinstallation of auxiliary FI package, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas where protective finish has been removed. The lacquer is not required on corrosion resistant steel.

i. If auxiliary FI package is to be replaced, note any difference in quantity of redundant seals on transducers between removed and replacement packages. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

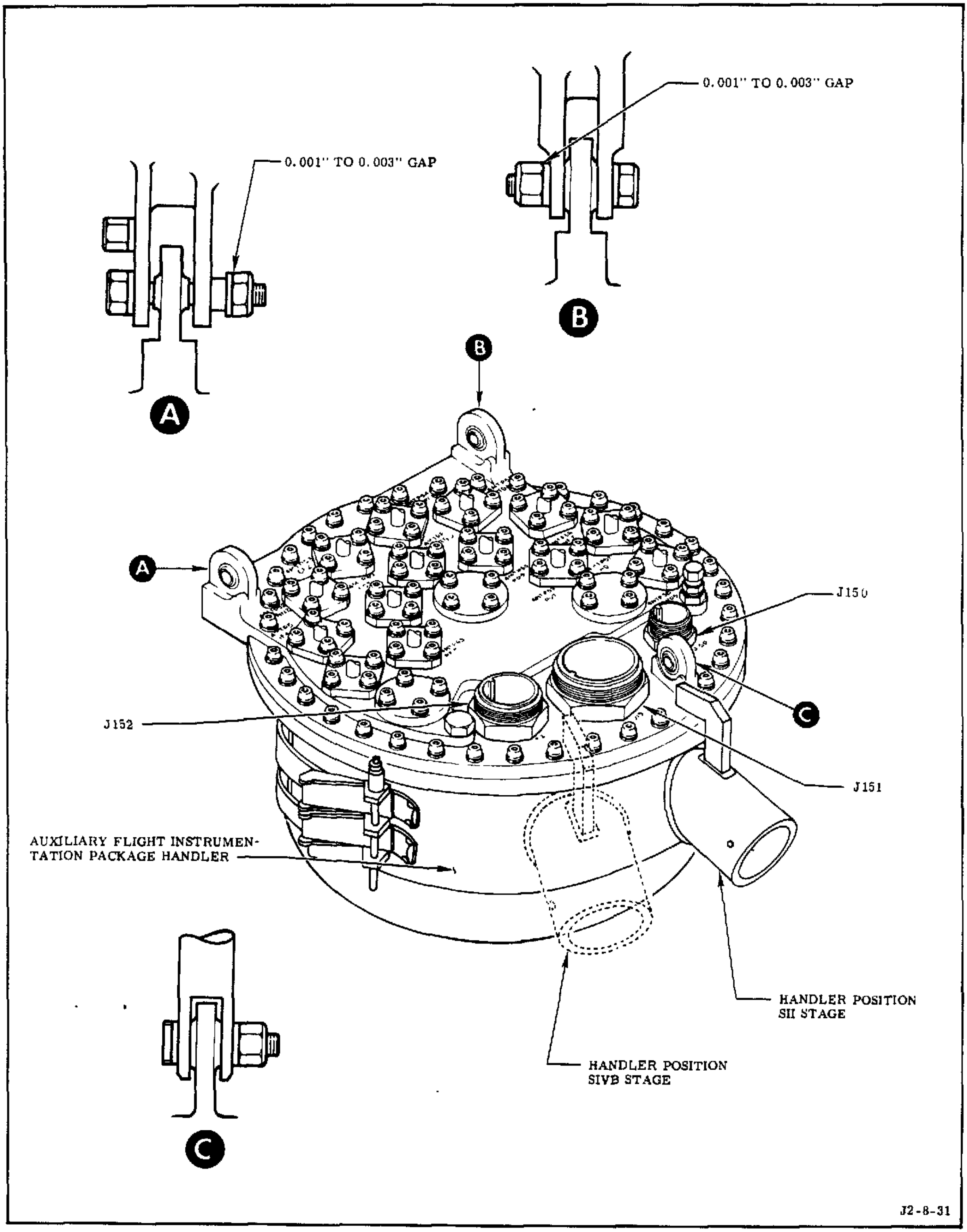


Figure 3-5. Auxiliary Flight Instrumentation Package

3-21. REMOVING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE (STACKED SII STAGE). (See figure 3-5.) This procedure removes the auxiliary FI package using specialized handling equipment for stacked stages. However, the weight of the auxiliary FI package (approximately 30 pounds) does not require the use of this equipment and may be removed manually (paragraph 3-20).

a. Obtain the following: (Item 4 is required only if launch tower umbilical arm is to be used for transporting component from stage.)

(1) Auxiliary FI package handler 9027225 from Engine Components Installer G4071.

(2) Component handling cart 9026253-11 from engine components installer set 9026251.

(3) Component handler universal lifting sling 9016779.

(4) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251.

b. Assemble track (refer to section V) around engine from which auxiliary FI package is to be removed. Position hoist at track station 24 for engine positions 1 through 4, or track station 9 for engine position 5.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove support clamps as required to gain access for removal of auxiliary FI package. Note location and position of clamps for reinstallation.

e. Disconnect and secure electrical connectors (paragraph 3-30) P150, P151, and P152.

f. Cut instrumentation lines to auxiliary FI package, and protect opened lines. (Refer to section VI for tube-cutting requirements.)

g. Attach handler to auxiliary FI package. (See figure 3-5.) Wrap handler strap around package and secure with ball-lock pin.

h. Connect hoist to handler, and secure connection with ball-lock pin. (See figure 3-6.)

i. Support weight of auxiliary FI package with hoist, and disconnect ground cable from thrust chamber bracket, and remove nuts, washers, bolts, and spacer that attaches FI package to thrust chamber and strut.

j. If it is expected that more than 7 days will elapse before reinstallation of auxiliary FI package, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas where protective finish has been removed. The lacquer is not required on corrosion resistant steel.

k. If auxiliary FI package is to be replaced, note any difference in quantity of redundant seals between removed and replacement packages. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound.

(2) Arm, +37.8 inches.

(3) Moment, 9.5 in-lb.

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

l. Using hoist, move auxiliary FI package to an accessible area near stage access door.

m. Remove handler (with auxiliary FI package attached) from hoist and temporarily place on protective pad.

n. Install component handler universal lifting sling on handler and secure with ball-lock pin. The combined weight of the auxiliary FI package, sling, and handler is approximately 37 pounds.

o. Using lifting eye on sling, manually transport auxiliary FI package through stage access door and place package in component handling cart.

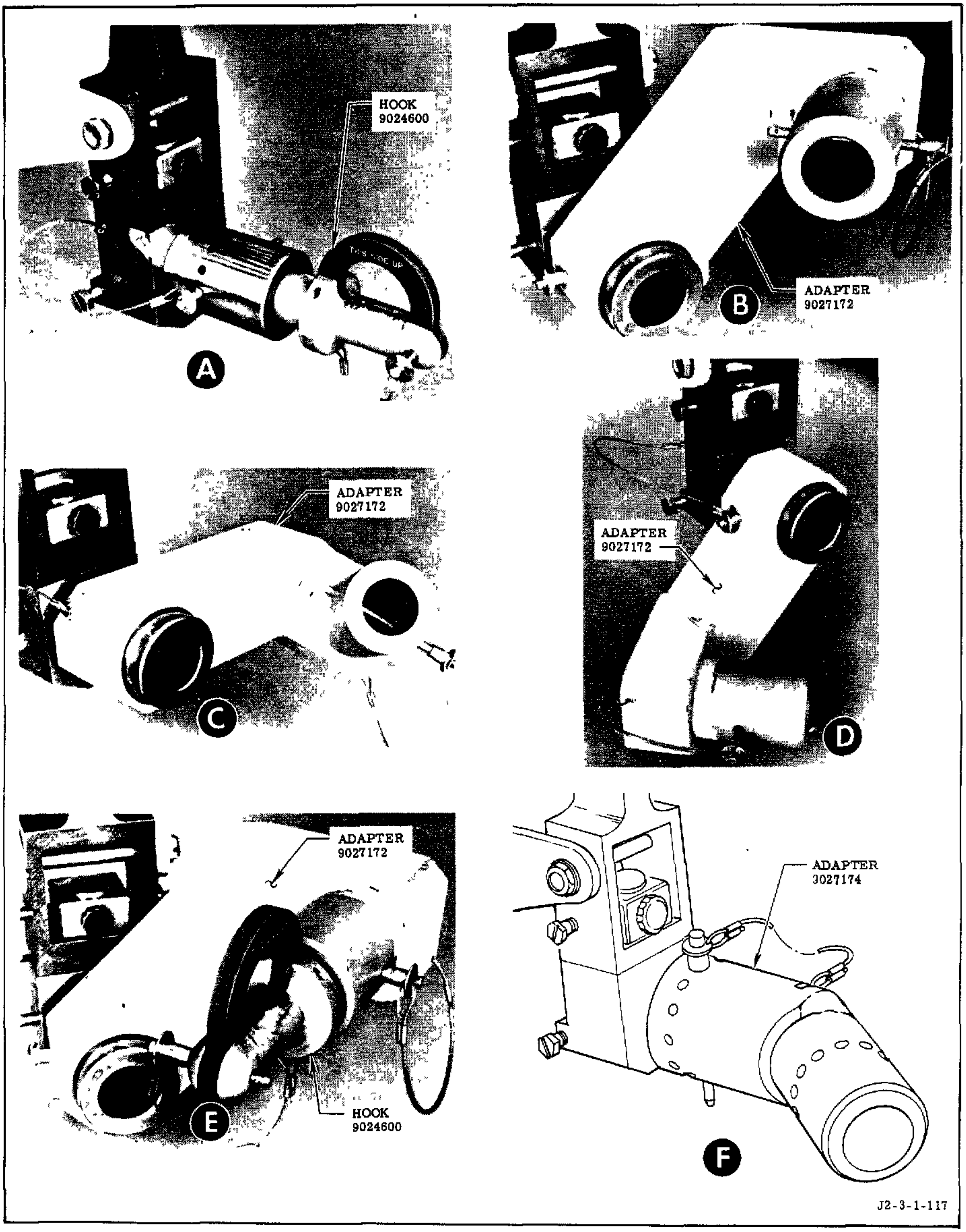


Figure 3-6. Hoist Adapter and Extension Arrangements (Sheet 1 of 2)

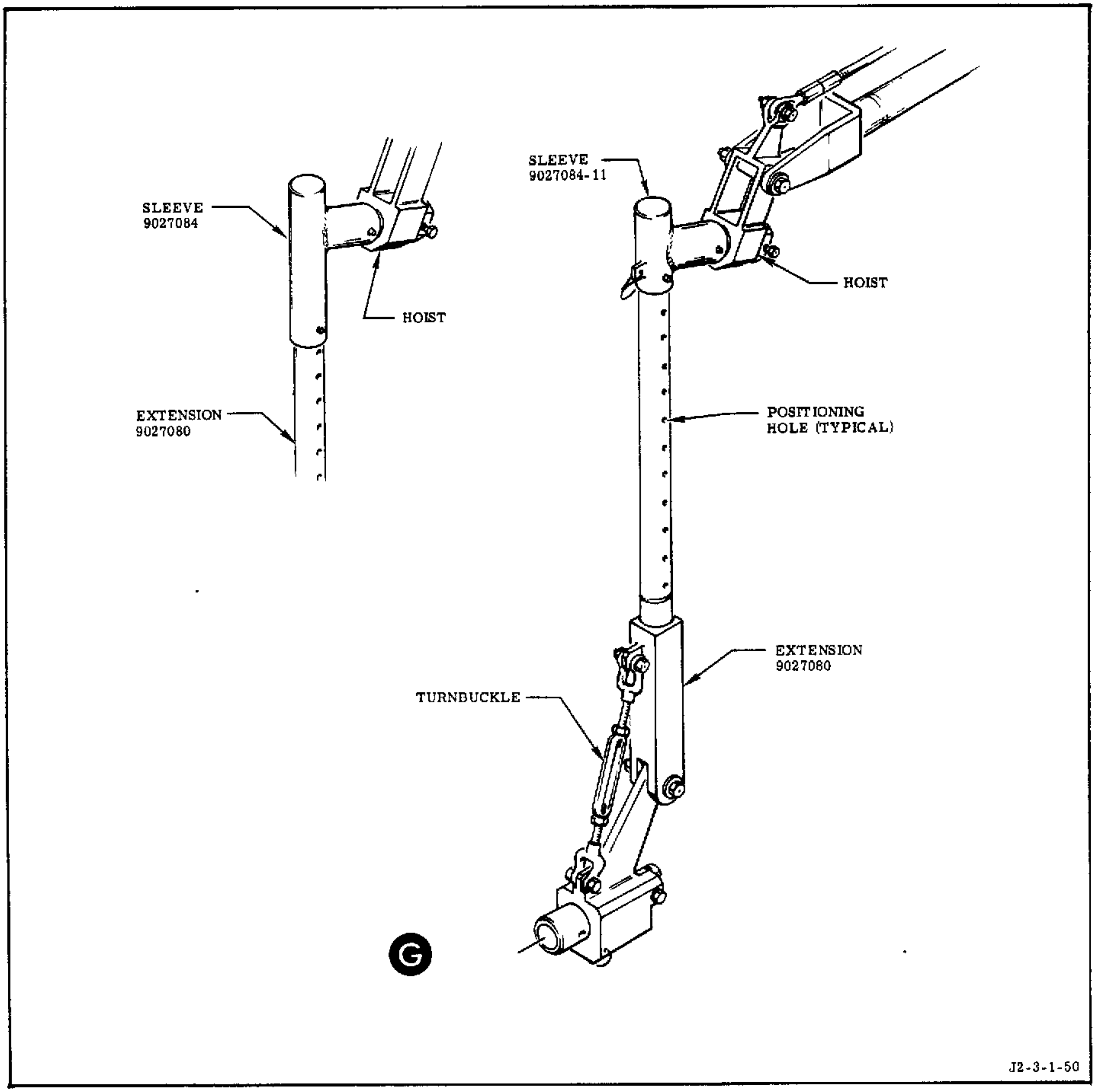


Figure 3-6. Hoist Adapter and Extension Arrangements (Sheet 2 of 2)

3-22. REMOVING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE (STACKED SIVB STAGE). (See figure 3-5.) This procedure removes the auxiliary FI package using specialized handling equipment for stacked stages. However, the weight of the auxiliary FI package (approximately 30 pounds) does not require the use of this equipment and may be removed manually (paragraph 3-20).

a. Obtain the following: (Item 6 is required only if launch tower umbilical arm is used to transport component from vehicle.)

(1) Auxiliary FI package handler 9027225 from Engine Components Installer G4072.

(2) Extension 9027080 from Engine Components Installer G4072.

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072.

(4) Component handler universal lifting sling 9016779.

(5) Component handling cart 9026253-11 from engine components installer set 9026252.

(6) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026252.

b. Assemble track for auxiliary FI package removal. (Refer to section V.) Direction of turntable controls is optional.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove support clamps as required to gain access for removal of auxiliary FI package. Note location and position of clamps for reinstallation.

e. Disconnect and secure electrical connectors (paragraph 3-30) P150, P151, and P152.

f. Cut instrumentation lines to auxiliary FI package, and protect opened lines. (Refer to section VI for tube cutting requirements.)

g. Install sleeve, extension, and handler on hoist. (See figure 3-6, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

h. Manipulate hoist to lower handler through opening in which lower work platform is installed, and orient handler with package.

i. Attach handler to auxiliary FI package. (See figure 3-5.) Wrap handler strap around package and secure with ball-lock pin.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

j. Support auxiliary FI package by manipulation of hoist and turnbuckle on extension. If turnbuckle is extended, do not extend it beyond a minimum of one thread evident in turnbuckle barrel. Make sure side load does not exist on auxiliary FI package.

k. Disconnect ground cable from thrust chamber bracket, and remove nuts, washers, bolts, and spacer that attach FI package to thrust chamber and strut.

l. If it is expected that more than 7 days will elapse before reinstallation of auxiliary FI package, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas where protective finish has been removed. The lacquer is not required on corrosion resistant steel.

m. If auxiliary FI package is to be replaced, note any difference in quantity of redundant seals on removed and replacement packages. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound.

(2) Arm, +37.8 inches.

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

n. Make sure auxiliary FI package is free of engine; then with hoist and extension turnbuckle, move auxiliary FI package clear of engine and through opening in which lower work platform is installed. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in raising component through stage work deck.

NOTE

Because of the remoteness of the hoist operator from the auxiliary FI package and deflection of the hoisting equipment, it is recommended that a technician guide the package and otherwise assist the hoist operator.

o. Using hoist, move auxiliary FI package to an accessible area near stage access door.

p. Remove handler (with auxiliary FI package attached) from hoist and temporarily place on protective pad.

q. Install component handler universal lifting sling on handler and secure with ball-lock pin. The combined weight of the auxiliary FI package, sling, and handler is approximately 37 pounds.

r. Using lifting eye on sling, manually transport auxiliary FI package through stage access door and place package in component handling cart.

3-23. INSTALLING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE. (See figure 3-5.) This procedure is for manual installation of the auxiliary FI package. If the specialized component handling equipment for stacked stages is to be used, refer to paragraph 3-24 or 3-25, as applicable.

a. Obtain a milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent.

b. If component is to be installed on engine in an SIVB stacked stage, install access work platform adjacent to auxiliary FI package. Refer to section V for procedures for installing access work platform.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

cA. Check pressure in auxiliary FI package. (Refer to R-3825-1B.)

d. If auxiliary FI package has been reworked or is being replaced, note any difference in quantity of redundant seals between removed package and package being installed. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

e. Position auxiliary FI package on engine, and secure package to brackets on thrust chamber with bolts, washers, spacer, and nuts. (See figure 3-5.) Do not tighten bolts at this time.

f. Secure package to strut with pin, washer, and nut. Torque nut to 50-70 in-lb.

g. Tighten fasteners that attach package to brackets until 0.001 to 0.003 inch gap exists between nut and washer. (See figure 3-5.)

WARNING

> The following step specifies methyl-ethyl-ketone (Federal Specification TT-M-261), which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

gA. Remove protective coating of blue-tinted lacquer from bonding area using cloth dampened with methyl-ethyl-ketone (Federal Specification TT-M-261).

h. Using 320-grit (or finer) abrasive cloth or paper, clean contact surfaces of ground cable terminal and its mating surface of all protective finishes and foreign material.

i. Connect ground cable to bracket on thrust chamber bolt and washer. Torque bolt to 27-33 in-lb and safetywire.

j. Using milliohmmeter, measure bonding resistance from auxiliary FI package to thrust chamber. Bonding resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded juncture if structure is suspect for excessive resistance. Complete step k within 24 hours of completion of resistance check; otherwise repeat resistance check.

k. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to areas from which the protective finish has been removed to obtain a metal-to-metal bond. The lacquer is not required on corrosion resistant steel.

l. Weld lines to instrumentation taps listed in figure 3-7. (Refer to section VI for welding requirements.) (Figure lists taps in an alphanumeric sequence and does not indicate sequence of welding.) Weld tubes in any sequence that results in efficient use of weld and purge times.

m. Connect electrical connectors (paragraph 3-31) P150, P151, and P152.

n. Reinstall all line support clamps (section I), and torque screws to 24-30 in-lb.

o. Refer to section IV for test requirements.

3-24. INSTALLING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE (STACKED SII STAGE). (See figure 3-5.) This procedure installs the auxiliary FI package using specialized handling equipment for stacked stages. However, the weight of the auxiliary FI package (approximately 30 pounds) does not require the use of this equipment and may be installed manually (paragraph 3-23).

a. Obtain the following: (Item 4 is required only if launch tower umbilical arm is used to transport component from vehicle.)

(1) Auxiliary FI package handler 9027225 from Engine Components Installer G4071.

(2) Component handler universal lifting sling 9016779.

(3) Component handling cart 9026253-11 from engine components installer set 9026251.

(4) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251.

(5) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

bA. Check pressure in auxiliary FI package. (Refer to R-3825-1B.)

c. Using component handling cart, transport auxiliary FI package to vehicle.

d. If auxiliary FI package has been reworked or is being replaced, note any difference in quantity of redundant seals between removed

CF2

CO3

GF4

GO5

HF2 (removed on engines incorporating MD172, MD206, MD269, MD282, MD296, MD313, or MD315 change)

HO1

NN1 (added on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)

NN2

PF5

PO6

PO7 (removed on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)

PO8

PO9

TF1 (added on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)

TG3

TG4

Figure 3-7. Auxiliary Flight Instrumentation Package Instrumentation Taps

package and package being installed. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

e. Install handler on auxiliary FI package in position shown in figure 3-5. Wrap handler straps around auxiliary FI package and secure with ball-lock pin.

f. Attach component handler universal lifting sling to handler and secure with ball-lock pin.

g. Using component handler universal lifting sling as a handle, manually carry auxiliary FI package into stage and lay package on a protective pad on work deck.

NOTE

The combined weight of the auxiliary FI package, sling, and handler is approximately 37 pounds.

h. Remove component handler universal lifting sling from handler.

i. Attach handler with auxiliary FI package to hoist. Secure with ball-lock pin.

j. Using hoist, move auxiliary FI package into position on engine.

k. Secure package to brackets on thrust chamber with bolts, washers, spacer, and nuts. (See figure 3-5.) Do not tighten bolts at this time.

l. Secure package to strut with pin, washers, and nut. Torque nut to 50-70 in-lb.

m. Tighten fasteners that attach package to brackets until 0.001 to 0.003 inch gap exists between nut and washer. (See figure 3-5.)

n. Remove handler from auxiliary FI package.

o. Disassemble track. (Refer to section V.)

WARNING

The following step specifies methyl-ethyl-ketone (Federal Specification TT-M-261), which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

oA. Remove protective coating of blue-tinted lacquer from bonding area using cloth dampened with methyl-ethyl-ketone (Federal Specification TT-M-261).

p. Using 320 grit (or finer) abrasive cloth or paper, clean contact surfaces of ground cable terminal and its mating surface of all protective finishes and foreign material.

q. Connect ground cable to bracket on thrust chamber with bolt and washer. Torque bolt to 27-33 in-lb and safetywire.

r. Using milliohmmeter, measure bonding resistance from auxiliary FI package to thrust chamber. Bonding resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded juncture if structure is suspect for excessive resistance. Complete step s within 24 hours of completion of resistance check; otherwise repeat resistance check.

s. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne), to areas from which the protective finish has been removed to obtain a metal-to-metal bond. The lacquer is not required on corrosion resistant steel.

t. Weld lines to instrumentation taps listed in figure 3-7. (Refer to section VI for welding requirements.) (Figure lists taps in an alphanumeric sequence and does not indicate sequence of welding.) Weld tubes in any sequence that results in efficient use of weld and purge times.

u. Connect electrical connectors (paragraph 3-31) P150, P151, and P152.

v. Reinstall all line support clamps (section I), and torque screws to 24-30 in-lb.

w. Refer to section IV for test requirements.

3-25. INSTALLING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE (STACKED SIVB STAGE). (See figure 3-5.) This procedure installs the auxiliary FI package using specialized handling equipment for stacked stages. However, the weight of the auxiliary FI package (approximately 30 pounds) does not require the use of this equipment and may be installed manually (paragraph 3-23).

a. Obtain the following:

(1) Auxiliary FI package handler 9027225 from Engine Components Installer G4072.

(2) Extension 9027080 from Engine Components Installer G4072.

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072.

(4) Component handler universal lifting sling 9016779.

(5) *Component handling cart* 9026253-11 from engine components installer set 9026252.

(6) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

bA. Check pressure in auxiliary FI package. (Refer to R-3825-1B.)

c. Using component handling cart, transport auxiliary FI package to vehicle.

d. If auxiliary FI package has been reworked or is being replaced, note any difference in quantity of redundant seals between removed package and package being installed. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound.

(2) Arm, +37.8 inches.

(3) Moment, 9.5 in-lb.

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

e. Install handler on auxiliary FI package in position shown in figure 3-5. Wrap handler straps around auxiliary FI package and secure with ball-lock pin.

f. Attach component handler universal lifting sling to handler and secure with ball-lock pin.

g. Using component handler universal lifting sling as a handle, manually carry auxiliary FI package into stage, and lay package on a protective pad on work deck.

NOTE

The combined weight of the auxiliary FI package, sling, and handler is approximately 37 pounds.

h. Remove component handler universal lifting sling from handler.

i. Install sleeve and extension on hoist. (See figure 3-6, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

j. Attach handler with auxiliary FI package to extension. Secure with ball-lock pin.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

k. Using hoist, lower auxiliary FI package through opening in which lower access platform is installed and position on engine. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in lowering component through stage work deck.

NOTE

Because of the remoteness of the hoist operator from the auxiliary FI package and deflection of the hoisting equipment, it is recommended that a technician guide the package and otherwise assist the hoist operator.

l. Secure package to brackets on thrust chamber with bolts, washers, spacer, and nuts. (See figure 3-5.) Do not tighten bolts at this time.

m. Secure package to strut with pin, washers, and nut. Torque nut to 50-70 in-lb.

n. Tighten fasteners that attach package to clevises until 0.001 to 0.003 inch gap exists between nut and washer. (See figure 3-5.)

o. Remove handler from auxiliary FI package.

p. Remove handler, extension, and sleeve from hoist.

q. Disassemble track. (Refer to section V.)

WARNING

The following step specifies methyl-ethyl-ketone (Federal Specification TT-M-261), which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

qA. Remove protective coating of blue-tinted lacquer from bonding area using cloth dampened with methyl-ethyl-ketone (Federal Specification TT-M-261).

r. Using 320-grit (or finer) abrasive cloth or paper, clean contact surfaces of ground cable terminal and its mating surface of all protective finishes and foreign material.

s. Connect ground cable to bracket on thrust chamber with bolt and washer. Torque bolt to 27-33 in-lb and safetywire.

t. Using milliohmmeter, measure bonding resistance from auxiliary FI package to thrust chamber. Bonding resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded juncture if structure is suspect for excessive resistance. Complete step u within 24 hours of completion of resistance check; otherwise repeat resistance check.

u. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to areas from which the protective finish has been removed to obtain a metal-to-metal bond. The lacquer is not required on corrosion resistant steel.

v. Weld lines to instrumentation taps listed in figure 3-7. (Refer to section VI for welding requirements.) (Figure 3-7 lists taps in an alphanumeric sequence and does not indicate sequence of welding.) Weld tubes in any sequence that results in efficient use of weld and purge times.

w. Connect electrical connectors (paragraph 3-31) P150, P151, and P152.

x. Reinstall all line support clamps (section I), and torque screws to 24-30 in-lb.

y. Refer to section IV for test requirements.

3-26. AUXILIARY FLIGHT INSTRUMENTATION PACKAGE AND PRIMARY FLIGHT INSTRUMENTATION PACKAGE TRANSDUCERS.

3-27. REMOVING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE AND PRIMARY FLIGHT INSTRUMENTATION PACKAGE TRANSDUCERS. (See figure 3-8.)

WARNING

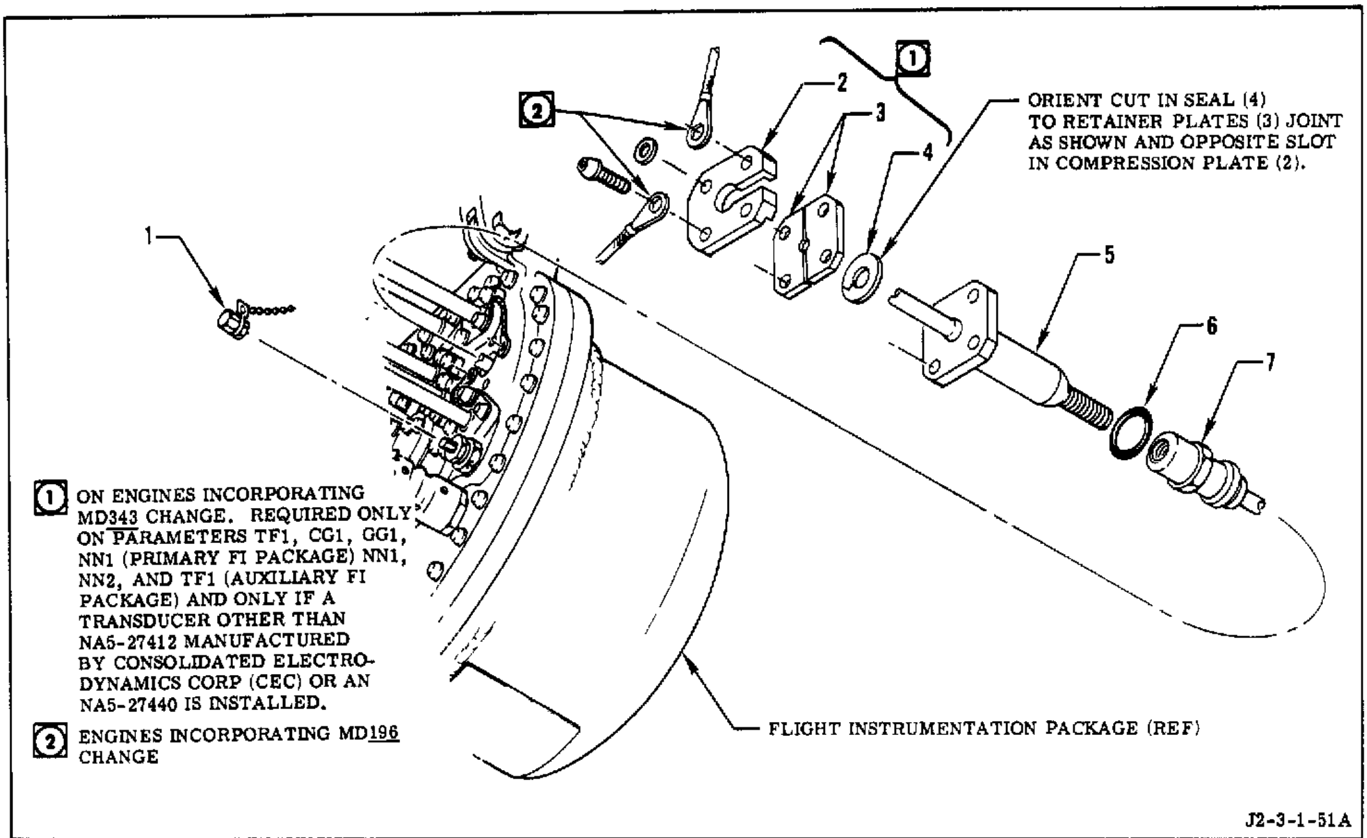
Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain a pressure transducer removal toolkit 9024999 or adapter T-5044633.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove support clamps, as necessary, to disconnect and remove selected transducer. Note location and position of clamps for reinstallation.

d. Cut line to transducer to be removed, and protect opened lines. (Refer to section VI for tube-cutting requirements.)



Index No.	Description	Index No.	Description
1	Cap	5	Transducer
2	Compression plate	6	Packing
3	Retainer plate	7	Electrical connector
4	Seal		

Figure 3-8. Auxiliary Flight Instrumentation Package and Primary Flight Instrumentation Package Transducers

e. Depressurize auxiliary FI package as follows:

(1) Cut lockwire and remove cap (1) from pressurizing valve.

(2) Back off pressurizing valve locknut 1/2 to 1 turn while holding valve to prevent it from loosening.

(3) Depress and hold pressurizing valve core until all pressure has vented.

f. Note, for reinstallation information, whether transducer to be removed from any of the following parameters incorporates a redundant seal (index numbers 2 through 4). TF1, CG1, GG1, NN1 (primary flight instrumentation package) and NN2, NN1, and TF1 (auxiliary flight instrumentation package).

NOTE

Engine weight and balance is affected by the deletion or addition of redundant seals.

g. Remove hardware that secures transducer (5) to be removed. If transducer (5) incorporates redundant seal, remove compression plate (2), retainer plates (3), and seal (4). If more than one transducer that incorporates redundant seals is removed, do not mix retainer plates (3), since they are matched sets.

h. Pull transducer (5) from package until electrical lead is exposed; then if transducer removal toolkit is being used, install transducer boss plug on electrical lead and push plug into opening in package. Secure plug to package with bolts and washers supplied in toolkit, if necessary, to prevent plug from falling out. If toolkit is not being used, wrap electrical lead with suitable material to prevent chafing of leads against package and electrical connector (7) from retracting into package.

NOTE

If electrical connector (7) is permitted to retract into the package, disassembly of the package may be necessary to retrieve the connector.

i. Using wrench from transducer removal toolkit, or adapter, disconnect electrical connector (7) from transducer (5).

j. Remove packing (6) from transducer.

k. If it is expected that more than 7 days will elapse before reinstallation of transducer apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas where protective finish has been removed. The lacquer is not required on corrosion resistant steel.

3-28. INSTALLING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE AND PRIMARY FLIGHT INSTRUMENTATION PACKAGE TRANSDUCERS. (See figure 3-8.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. If transducer is being replaced, verify that pressure transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain the following: (Item 2 required only if engine incorporates MD196 change.)

(1) Pressure transducer removal toolkit 9024999 or adapter T-5044633

(2) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure transducer, auxiliary FI package mating connections, threads in parent metal and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

d. Determine if transducer to be installed requires redundant seal and if total number of redundant seals on package will change due to transducer removal. (See figure 3-8 for redundant seal requirements.) A redundant seal is made up of index items (2) through (4). Engine weight and balance is affected by the following values for each difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +35.7 inches (primary FI package) or +37.8 inches (auxiliary FI package)

(3) Moment, 8.9 in-lb (primary FI package) or 9.5 in-lb (auxiliary FI package)

NOTE

The effect on the arm due to the physical location of redundant seals on either package is negligible.

e. Make sure transducer boss plug is installed in FI package or some mechanical means is employed to prevent the electrical lead for transducer from chafing on side of package.

f. Inspect transducer (5) and electrical connector (7) threads for residue of sealing compound used to lock the previously assembled parts together. If necessary, remove, by mechanical means, sufficient residue to permit complete mating of parts by hand.

WARNING

The following procedure specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

g. Using a clean, soft-bristle brush, apply methyl-ethyl-ketone (Federal Specification TT-M-261) to mating threads of electrical connector (7) and transducer (5). Do not allow the solvent to come in contact with contact pins or recesses. Wipe mating threads with clean nylon cloth No. 7815 (Victor Gloves, Inc); then apply a second coat of solvent and allow to air-dry for 10 minutes.

h. Connect electrical connector (7) to transducer (5) as follows:

(1) Lubricate (Method J, section I) packing (6) with petrolatum (Federal Specification VV-P-236), and install on flange of transducer (5).

(2) Connect electrical connector (7) (paragraph 3-31) on transducer (5), and tighten connector (7) handtight.

(3) Back off electrical connector (7) approximately 2-1/2 turns, and apply sealing compound, grade C (Loctite Corp) to first 2 exposed threads on transducer (5), immediately adjacent to electrical connector.

(4) Using wrench from toolkit, or adapter, torque electrical connector (7) to 40-50 in-lb.

i. Remove transducer boss plug, or other device used to secure electrical lead, from transducer port in FI package.

WARNING

The following step specifies methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

iA. Remove protective coating of blue-tinted lacquer from bonding area using cloth dampened with methyl-ethyl-ketone (Federal Specification TT-M-261).

j. On engines incorporated MD196 change, using abrasive cloth or paper, 320 grit (or finer), clean contact surfaces of ground cable terminal and mating surfaces of all protective finishes and foreign material.

k. Install transducer (5). If redundant seal is required, install index items (2) through (4), orienting them as shown in figure 3-8. Note that seal retainer plates (3) are a matched set. Each retainer plate must bear the same serial number. Use bolts RD111-3006-4223 if redundant seal is not installed. Use bolts RD111-3006-4216 if redundant seal is installed.

l. Cross-torque bolts in approximately 25 in-lb increments to 70-82 in-lb. Wait 30 minutes; then recheck final torque.

m. On transducers (5) that incorporate redundant seals, use a feeler gage and check for a maximum 0.0015-inch gap between transducer (5) flange and each corner of compression plate (2). If gap exceeds 0.0015 inch at one or more corners, replace seal (4) with a new seal. Repeat steps k through m.

n. Safetywire bolts.

o. On engines incorporating MD196 change, using milliohmmeter, measure resistance between transducer flange and FI package. Bonding resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded juncture if structure is suspect for excessive resistance. Complete step p within 24 hours of completion of resistance check; otherwise repeat resistance check.

p. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to areas from which the protective finish has been removed to obtain a metal-to-metal bond. The lacquer is not required on corrosion resistant steel.

q. Leak-test and pressurize FI package. (Refer to R-3825-1B.)

r. Weld transducer line. (Refer to section VI for welding requirements.

s. Refer to section IV for test requirements.

3-28A. DUMMY IGNITION DETECTOR AND BRACKET.

3-28B. REMOVING DUMMY IGNITION DETECTOR AND BRACKET. (See figure 3-8A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (paragraph 3-30) P19.

c. Remove bolts, washers, nuts, and spacers that secure dummy ignition detector bracket to flange and remove bracket and detector.

d. Remove screws, washers, and nuts that secure dummy ignition detector (J19A) to bracket and remove dummy ignition detector.

3-28C. INSTALLING DUMMY IGNITION DETECTOR AND BRACKET. (See figure 3-8A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Attach dummy ignition detector to bracket with screws, washers, and nuts. Orient keyway as shown in figure 3-8A and torque nuts to 6-8 in-lb.

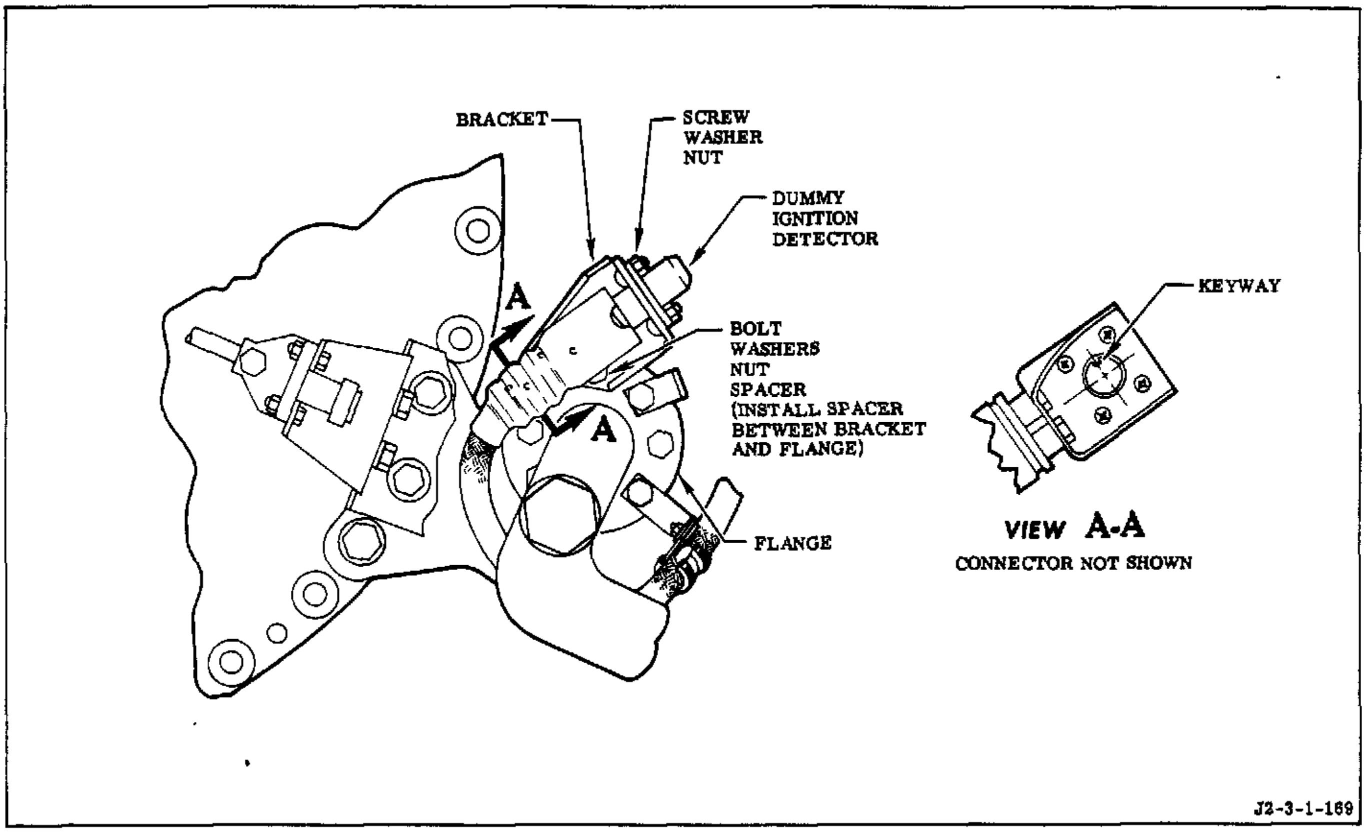


Figure 3-8A. Dummy Ignition Detector and Bracket

c. Attach bracket to flange with bolts, washers, nuts, and spacers. Install countersunk washer under head of bolt and flat washer next to nut. Torque nuts to 30-40 in-lb. A minimum of one thread must protrude beyond nut. If this requirement cannot be met, remove flat washer from under nut.

d. Connect electrical connector (paragraph 3-31) P19.

3-29. ELECTRICAL CONNECTORS.

3-29A. Procedures for disconnecting and connecting electrical connectors (paragraphs 3-30 through 3-31A) contain specific allowable deviations that are applicable to stage interface electrical connectors only. The allowable deviation is in a note following the procedural step.

3-30. DISCONNECTING THREADED-TYPE ELECTRICAL CONNECTORS. To prevent corrosion and other types of damage to electrical connectors and electrical harnesses, this procedure must be followed when disconnecting electrical connectors.

CAUTION

Failure to adhere to this procedure when disconnecting electrical connectors can result in damage to equipment and launch abort.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove support clamps and adjacent hardware as necessary, to allow easy disconnecting of electrical connectors and to prevent damage to electrical harness.

c. When connector P1, P2, or P3 must be disconnected, disconnect P3 before P2, and disconnect P2 before disconnecting P1.

d. Slide thermal protecting boot back on harness (also on adjacent connectors when necessary to obtain better access); then cut and remove lockwire from connector to be disconnected.

e. Using appropriate wrench, loosen and back off connector coupling nut until nut can be turned by hand.

CAUTION

Pulling or twisting cables or overmolds can result in extensive damage to the armored harness.

NOTE

Overmolds are not moisture seals; therefore, they may or may not adhere to the connector adapter. The overmold function is to secure the armor braid pigtail and aid in securing the thermal protecting boot in position.

f. Disconnect connectors by grasping connector by hand and alternately pulling straight out and turning coupling nut until disconnected. Do not pull or twist cable or overmolds, and do not bend cable to radius of less than one times outside diameter of cable. Immediately inspect receptacles and plugs for the following:

(1) Insulators RD421-5001-0016 or RD421-5001-0012 (figure 3-9) installed on male connector pins. Remove and discard insulators, using No. 10, 11, or 12 crochet needle (one in toolkit 9024994).

(2) Contamination.

(a) Visually inspect connector for dust, dirt, moisture, excess lubricant, or foreign particles using 4-power (maximum) magnification.

(b) If contamination is found, clean plug. If contamination can be removed by vacuuming, vacuum connector, otherwise clean connector as outlined in section I.

Plug RDI Number	Torque[e] (in-lb)	Receptacle RDI Number	Description
P1	140-175	J1[a][b]	ECA
P2	155-185	J2	ECA
P3	130-165	J3	ECA
P13	40-50	J13[a]	Helium control solenoid
P14	40-50	J14[a]	Ignition-phase control solenoid
P15	40-50	J15[a]	Mainstage control solenoid
P16	40-50	J16	Start tank pressure switch
P17	40-50	J17[a]	Helium emergency vent control solenoid
P18	40-50	J18[a]	Start tank discharge control solenoid
P19	40-50	J19[a]	Ignition detector probe
P20	40-50	J20[a]	Mainstage OK pressure switch No. 1
P21	30-40	J21	Spare connector
P22	30-40	J22[a]	Fuel injection temperature sensor
P25	80-100	J25	To facility instrumentation connector
P26	40-50	J26[a]	Mainstage OK pressure switch No. 2
P36[c]	90-115	J36[a][c]	PU valve
P36[d]	90-115	J36A[d]	MRCV (solenoid valve) jumper harness
P36A[d]	None	J36[d]	MRCV solenoid valve
P38	84-115	J38	Electrical interface
P51	140-187	J51	Electrical interface
P54	155-216	J54	Electrical interface
P55	40-50	J55	Start tank emergency vent valve
P100	80-100	J100[a]	Primary FI package
P101	155-185	J101	Primary FI package
P102	100-125	J102	Primary FI package
P103	130-165	J103[a]	Primary FI package
P104	130-165	J104	Primary FI package
P105	72-100	J105	Electrical interface
P106	130-165	J106	Electrical interface
P107	130-165	J107	Electrical interface
P108	155-216	J108	Electrical interface

(a) Install insulators RD421-5001-0016 on all size 16 connector pins.
(b) Install insulators RD421-5001-0012 on 7 size 12 connector pins.
(c) Engines not incorporating MD366 or MD371 change.
(d) Engines incorporating MD366 or MD371 change.
(e) Same value for torquing closures.

Figure 3-9. Electrical Connectors (Sheet 1 of 3)

Plug RDI Number	Torque[e] (in-lb)	Receptable RDI Number	Description
P109	96-125	J109	Electrical interface
P110	40-50	J110[a]	Main fuel flowrate
P111	40-50	J111[a]	Main oxidizer flowrate
P112	40-50	J112[a]	Fuel turbopump speed
P113	40-50	J113[a]	Oxidizer turbopump speed
P114	60-80	J114[a]	MFV position indicator
P115	60-80	J115[a]	MOV position indicator
P116	60-80	J116[a]	GG control valve position indicator
P117	60-80	J117[a]	OTBV position indicator
P118	60-80	J118[a]	STDV position indicator
P119[c]	60-80	J119[a][c]	PU valve position indicator
P119[d]	60-80	J119A[d]	MRCV (position indicator) jumper harness
P119A[d]	None	J119[d]	MRCV position indicator
P120	30-40	J120[a]	ASI valve position indicator
P122	30-40	J122[a]	Helium tank gas temperature (NNT1)
P123	40-50	J123[a]	Start tank gas temperature (TFT1)
P124	40-50	J124[a]	Fuel turbopump discharge temperature (PFT1)
P125	40-50	J125[a]	Oxidizer turbopump discharge temperature (POT3)
P126	30-40	J126	Fuel turbine inlet temperature (TGT1)
P127	30-40	J127	Oxidizer turbine inlet temperature (TGT3)
P128	30-40	J128	Oxidizer turbine outlet temperature (TGT4)
P129	30-40	J129[a]	Thrust chamber jacket temperature No. 1 (CS1)
P130	30-40	J130[a]	Thrust chamber jacket temperature No. 2 (CS1a)
P131	30-40	J131[a]	Fuel injection manifold temperature (CFT2)
P132	30-40	J132[a]	Oxidizer bleed valve closed position indicator
P133	30-40	J133[a]	Fuel bleed valve closed position indicator
P135	40-50	J135[a]	Fuel turbopump discharge pressure
P136	40-50	J136[a]	Oxidizer turbopump discharge pressure
P137	40-50	J137[a]	Thrust chamber pressure
P138	40-50	J138[a]	GG chamber or fuel turbine inlet pressure
P139	40-50	J139[a]	Helium tank pressure
P140	40-50	J140[a]	Start tank pressure

(a) Install insulators RD421-5001-0016 on all size 16 connector pins.
(c) Engines not incorporating MD366 or MD371 change.
(d) Engines incorporating MD366 or MD371 change.
(e) Same value for torquing closures.

Figure 3-9. Electrical Connectors (Sheet 2 of 3)

Plug RDI Number	Torque[e] (in-lb)	Receptacle RDI Number	Description
P141	40-50	J141[a]	Fuel turbopump interstage pressure (PF6)
P150	80-100	J150[a]	Auxiliary FI package
P151	155-185	J151[a]	Auxiliary FI package
P152	130-165	J152[a]	Auxiliary FI package
P153	96-125	J153	Electrical interface
P154	155-216	J154	Electrical interface
P155	108-145	J155	Electrical interface
P156	155-216	J156	Electrical interface
P157	40-50	J157[a]	Heat exchanger oxidizer outlet temperature (HOT2)
P158	40-50	J158[a]	Fuel bleed valve temperature (GFT1)
P159	40-50	J159[a]	Oxidizer bleed valve temperature (GOT2)
---	30-40	J160	GG overtemperature (GGT1)
P161	30-40	J161[a]	Fuel turbopump bearing temperature (PST1)
P162	30-40	J162[a]	Oxidizer turbopump bearing coolant temperature (POT4)
Closure	30-40	J163	Spare
P180	30-40	J180	Start tank emergency vent valve harness
P181	40-50	J181[a]	GG oxidizer injector pressure
P182	40-50	J182[a]	GG fuel injector pressure
P183	40-50	J183[a]	Engine regulator outlet pressure
P184	40-50	J184[a]	Main fuel injector pressure
P185	40-50	J185[a]	PU valve or MRCV inlet pressure
P186	40-50	J186[a]	Oxidizer turbine outlet pressure
P187	40-50	J187[a]	Helium tank pressure redundant (NN1)
P188	40-50	J188[a]	Heat exchanger oxidizer inlet pressure
P189	40-50	J189[a]	Oxidizer turbopump primary seal cavity pressure
P190	40-50	J190[a]	Start tank pressure redundant (PO7)
P191	40-50	J191[a]	PU valve or MRCV outlet pressure
P192	40-50	J192[a]	Oxidizer turbine inlet pressure
P193	40-50	J193[a]	Main oxidizer injector pressure
P194	40-50	J194[a]	Fuel turbopump balance piston cavity pressure

(a) Install insulators RD421-5001-0016 on all size 16 connector pins.
(e) Same value for torquing closures.

Figure 3-9. Electrical Connectors (Sheet 3 of 3)

(3) Bent contact pins.

(a) Contact pins that are not bent more than 20 degrees from connector axis may be straightened by using a mating socket contact or insulator installing tool 9024995. (See figure 3-10.) Do not use pliers or other tools that can damage pin. Pins bent more than 20 degrees are not acceptable. Contact Rocketdyne Logistics Program Support.

(b) Visually inspect contact pins for cracks using 4-power (maximum) magnification. If contact pins are cracked, replace harness or component.

(c) Contact pins with more than one bend, regardless of angularity, are not acceptable. (See figure 3-10.) Replace harness or component.

(4) Bent, misalined, or damaged contact sockets (female) that would or may impair proper mating with pin contacts are not acceptable. Contact Rocketdyne Logistics Program Support.

(5) Extended or recessed contact pins and contact sockets. If limits specified in figure 3-10 are exceeded, replace harness or component.

(6) Corrosion.

(a) Visually inspect contact pins and sockets for corrosion using 4-power (maximum) magnification.

(b) If corrosion is evident, clean connectors as outlined in section I. Corrosion-pitted pins and sockets are not acceptable. Contact Rocketdyne Logistics Program Support.

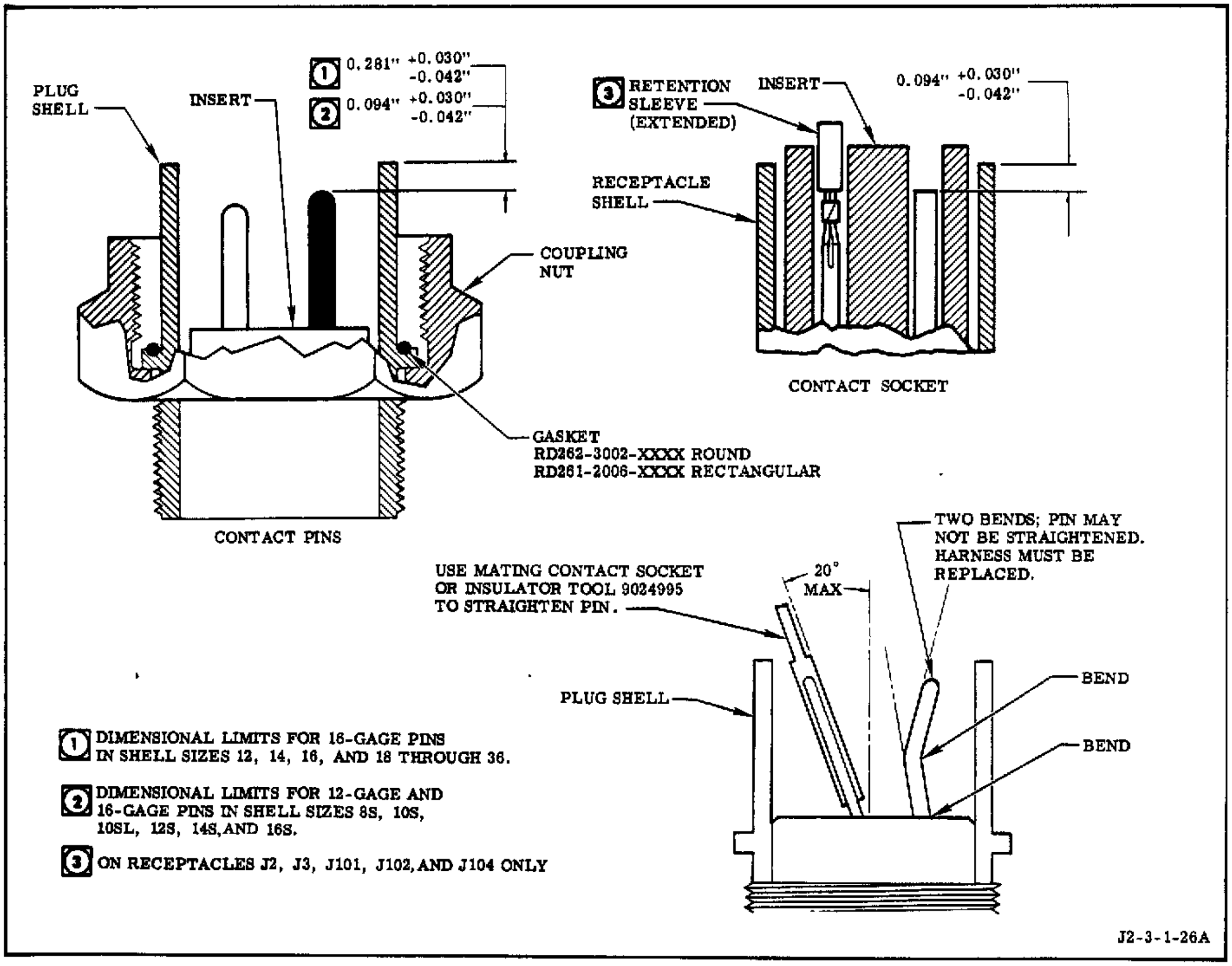


Figure 3-10. Threaded-Type Electrical Connector Damage Limits

(7) Cracked or split connector inserts (figure 3-10) are not acceptable.

(8) Broken connector shells and damaged sealing surfaces of connectors are not acceptable. Contact Rocketdyne Logistics Program Support.

g. Using a No. 10, 11, or 12 crochet hook and making sure not to damage gasket sealing surface, remove and replace plug gasket (use only rectangular gaskets RD261-2006-XXXX on gold color plugs and only round gaskets. RD262-3002-XXXX on olive color plugs). (Refer to R-3825-4 for gasket part number.)

h. Install clean, dry closures (refer to R-3825-4 for closure part numbers) on plug and receptacle; make sure receptacle closure has an undamaged gasket installed. Torque closure (see figure 3-9).

i. Secure loose cables and connectors to prevent damage to cables, connectors, and adjacent components.

3-30A. DISCONNECTING BAYONET-TYPE ELECTRICAL CONNECTORS. (High Reliability LJT). (See figure 3-10A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Relative movement between the barrel or shell and clamping nut can damage the harness.

aA. When performing this procedure, do not impose unnecessary torsional loads on any part of the harness or of the connector except for the connector coupling nut. Torsional loads can result in relative movement between the barrel or shell and clamping nut (see figure 3-10A) of the connector.

CAUTION

Pulling or twisting cables on overmolds, or bending cable to a radius of less than one times the outside diameter of the cable can result in extensive damage to the armored harness.

- Tools (wrenches, pliers, etc) must not be used for loosening connectors, since damage to connectors or components can result.

b. Noting clamp positions for reinstallation, remove support clamps as necessary, to allow easy disconnecting of electrical connectors and to prevent damage to electrical harness.

NOTE

Overmolds are not moisture seals; therefore, they may or may not adhere to the connector adapter. The overmold function is to secure the armor braid pigtail.

c. Remove thermal protecting boot; then cut and remove lockwire from connector to be disconnected.

d. Clean exterior of connector and cable as outlined in section I.

NOTE

Steps e and f must be performed in one continuous operation to prevent contamination.

e. Turn coupling nut counterclockwise by hand until nut turns freely; then separate plug from receptacle. Immediately inspect connector receptacles and plugs for contamination, corrosion, and damage, using a 4-power (maximum) magnification as follows:

(1) Contamination (dust, dirt, moisture, or foreign particles) is not acceptable. If contamination is found, clean interior of connector as outlined in section I.

(2) Corroded contact pins and contact sockets are not acceptable. If corrosion is evident, clean interior of connector as outlined in section I. Corrosion-pitted pins and sockets are not acceptable. Contact Rocketdyne Logistics Program Support for disposition.

(3) Cracked or split connector inserts are not acceptable. Contact Rocketdyne Logistics Program Support for disposition.

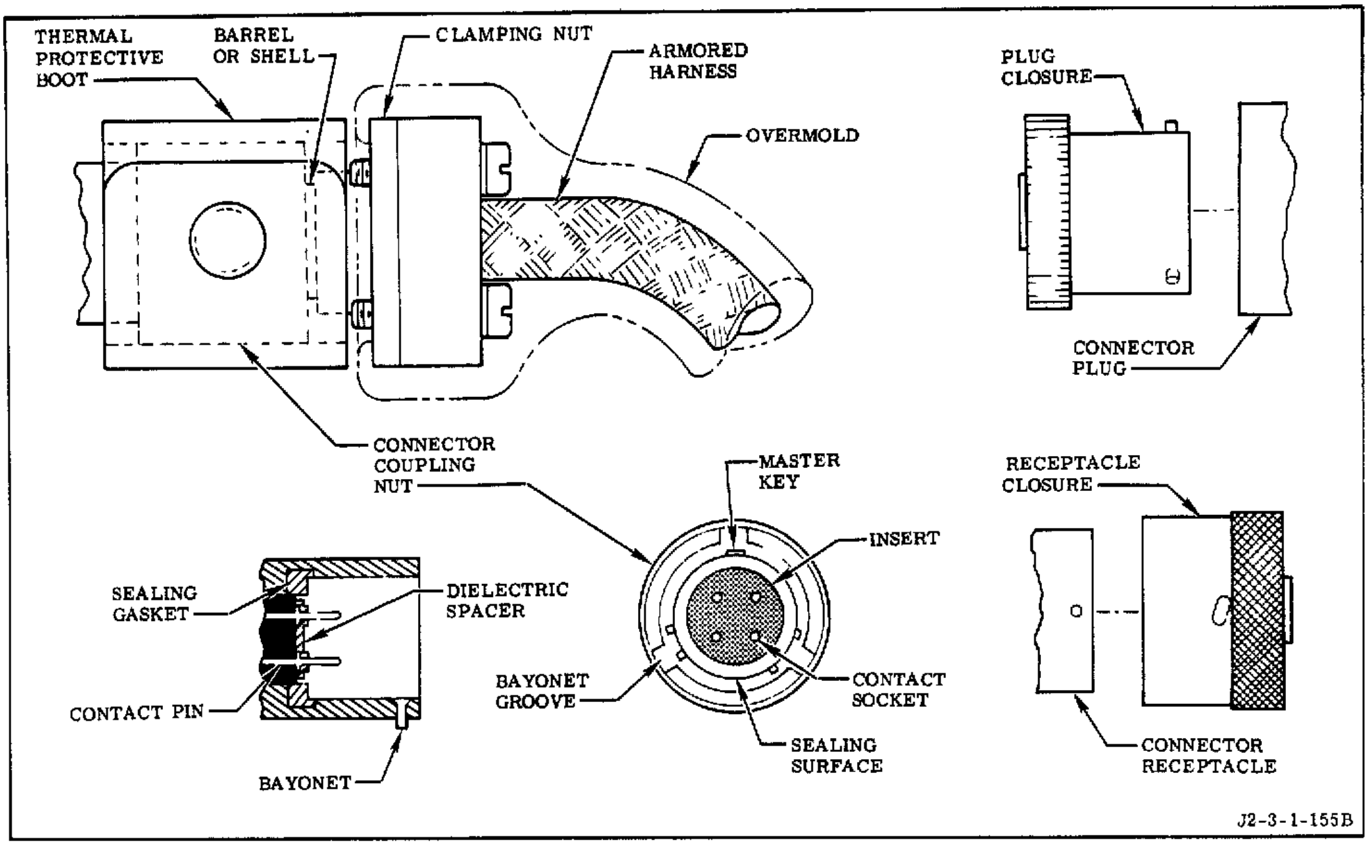


Figure 3-10A. Bayonet-Type Electrical Connectors (High Reliability LJT)

(4) Broken connector shells and damaged sealing surfaces of connectors are not acceptable. Contact Rocketdyne Logistics Program Support for disposition.

f. Make sure closures (plug closure RE265-6202-0011 and receptacle closure RE265-6201-0011) are clean and dry and seals in closures are undamaged. If seals are damaged, obtain new closures. To install plug closure, insert closure into plug; then turn plug coupling nut clockwise by hand until nut locks on closure bayonet pins. To install closure on receptacle, place closure over receptacle alining bayonet pins of receptacle over grooves in closure; then turn closure clockwise by hand until closure locks on receptacle bayonet pins.

g. Secure loose cables and connectors to prevent damage to cables, connectors, and adjacent components.

3-31. CONNECTING THREADED-TYPE ELECTRICAL CONNECTORS. This procedure must be a continuous operation, and if a delay in completion is encountered, all openings must be capped and the complete procedure repeated starting with step a. (Refer to R-3825-4 for part numbers.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

CAUTION

Failure to follow this procedure when connecting electrical connectors can result in damage to components and launch abort.

- Pulling or twisting cables or overmolds can result in extensive damage to the armored harness.

NOTE

Overmolds are not moisture seals; therefore they may or may not adhere to the connector adapter. The overmold function is to secure the armor braid pigtail and aid in securing the thermal protecting boot in position.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove connector protective closures, and inspect plug and receptacle for the following: (Do not pull or twist cable or overmolds, and do not bend cable to radius of less than one times outside diameter of cable.)

(1) Insulators RD421-5001-XXXX installed on male connector pins. If insulators have not previously been removed, remove and discard insulators using No. 10, 11, or 12 crochet needle (one in toolkit 9024994).

(2) Contamination.

(a) Visually inspect for dust, dirt, moisture, excess lubricant, or foreign particles using 4-power (maximum) magnification.

(b) If contamination is found, clean plug. If contamination can be removed by vacuuming, vacuum connector, otherwise clean connector as outlined in section I.

(3) Bent contact pins.

(a) Contact pins that are not bent more than 20 degrees from connector axis may be straightened by using a mating socket contact or insulator installing tool 9024995. (See figure 3-10.) Do not use pliers or other tools that can damage pin.

(b) After straightening, visually inspect contact pin for cracks. If contact pins are cracked, replace harness or component.

(c) Contact pins with more than one bend, regardless of angularity, are not acceptable. (See figure 3-10.) Replace harness or component.

(4) Bent or misalined contact sockets (female) are not acceptable. Contact Rocketdyne Logistics Program Support.

(5) Extended or recessed contact pins and contact sockets. Visually inspect connector for extended or recessed contact pins and contact sockets. If limits specified in figure 3-10 are exceeded, replace harness or component.

(6) Corrosion.

(a) Visually inspect connector for corroded contact pins and contact sockets using 4-power (maximum) magnification.

(b) If corrosion is found, clean as outlined in section I. Corrosion-pitted pins and sockets are not acceptable. Contact Rocketdyne Logistics Program Support.

(7) Cracked or split connector inserts are not acceptable.

(8) Broken connector shells are not acceptable. Replace cable or component.

(9) Damaged sealing surfaces. Remove nicks, burs, and scratches that would impair sealing function with 600-grit abrasive cloth or paper.

(10) Receptacles J2 and J3 on ECA and J101, J102, and J104 (on primary FI package) for socket contact retention sleeves extending beyond rubber insert. (See figure 3-10.) If retention sleeves are extending beyond rubber insert, replace ECA and/or primary FI package. Do not push retention sleeve back in place.

CAUTION

Damaging sealing surfaces can result in moisture entering the connector, causing corrosion damage to connector pins and sockets.

c. Using a No. 10, 11, or 12 crochet hook and making sure not to damage sealing surfaces, remove plug gasket (gasket between plug shell and coupling nut); however, do not remove gasket on pressure transducer electrical connectors inside primary and auxiliary FI packages. (Refer to R-3825-4 for part numbers.)

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

d. Dry plugs and receptacles with a jet of low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A) for 2 minutes minimum. Visually inspect for moisture. If moisture is still present, repeat step.

NOTE

Drying plugs and receptacles with nitrogen or air as noted in step d is recommended but not mandatory on stage interface electrical connectors.

e. If connector is coded (a) in figure 3-9 install insulators RD421-5001-0016 on male pins (7 insulators RD421-5001-0012 required on J1) using installation tool 9024995 from toolkit 9024994. Seat insulators around base of each pin. Visually inspect for bent or misalined pins.

NOTE

Insulators are required on receptacles with glass to metal seals (except when used for hot-gas temperature measurements) to minimize the possibility of metal chips, produced when mating connectors slightly misalined, causing a short from pin to ground.

f. Lubricate (Method A, section I) male threads of connector with FS1281 grease (Dow Corning Corp) (except do not apply grease to threads of transducer electrical connectors inside primary and auxiliary FI packages). Do not allow grease to contact pins, pin sockets, or inserts. Remove excess grease with a clean, lint-free cloth.

NOTE

Lubricating threads is recommended but is not mandatory on stage interface electrical connectors.

g. Obtain gasket(s), and spacer when required, for electrical plug. (Refer to R-3825-4 for part number(s) and effectivities.) Lubricate (Method J, section I) gasket(s) with FS1281 grease (Dow Corning Corp). Install gasket(s), and spacer when required, on plug.

NOTE

A spacer and an additional gasket are used in electrical plug P36 on engines J-2046, J-2056, and J-2062 only.

- Lubricating gaskets is recommended but is not mandatory on stage interface electrical connectors.

h. For ease of installation, make sure adjacent support clamps are removed; then connect electrical connectors P1, P2, and P3, in that order, as follows:

NOTE

For ease of safetywiring, lockwire MS20995N20 may be inserted in the lockwire hole before mating the connectors.

(1) Carefully aline keyways.

(2) Faces of plug and receptacle must be parallel.

(3) Carefully start plug into receptacle.

(4) Turn coupling nut by hand.

(5) Alternately push in on plug and turn coupling nut by hand until coupling nut is handtight.

(6) Using appropriate torque wrench, torque coupling nut to required torque in figure 3-9.

(7) After a minimum of 30 minutes, retorque to required torque in figure 3-9. (Except do not retorque electrical connectors if Loctite is used on mating threads.) Subsequent torque relaxation of installed connectors is a normal occurrence. Connectors must not be checked for torque and must not be retorqued after installation has been completed.

NOTE

Retorque is recommended but is not mandatory on stage interface electrical connectors.

(8) Safetywire connector.

(9) Install thermal protecting boot around connector.

(10) Install support and/or bonding clamps (section I), and torque screws to 24-30 in-lb.

(11) Make sure receptacle identification number (JXXX number) is stamped adjacent to receptacle. If the identification number is missing or not legible, use a rubber stamp with 0.25-inch letters and black ink 24F (The Pannier Corp) and stamp JXXX number adjacent to receptacle.

i. (Deleted)

j. If this procedure is not being performed as a reference from another procedure, refer to section IV for test requirements.

3-31A. CONNECTING BAYONET-TYPE ELECTRICAL CONNECTORS (High Reliability LJT). (See figure 3-10A.) This procedure must be a continuous operation; if a delay in completion is encountered, closures must be reinstalled and the complete procedure repeated starting with step a.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Relative movement between the barrel or shell and clamping nut can damage the harness.

aA. When performing this procedure, do not impose unnecessary torsional loads on any part of the harness or of the connector except for the connector coupling nut. Torsional loads can result in relative movement between the barrel or shell and clamping nut (see figure 3-10A) of the connector.

CAUTION

Pulling or twisting cables or overmolds, or bending cable to a radius of less than one times the outside diameter of the cable can result in extensive damage to the armored harness.

NOTE

Overmolds are not moisture seals; therefore, they may or may not adhere to the connector adapter. The overmold function is to secure the armor braid pigtail.

b. Remove connector protective closures and immediately inspect connector plug and receptacles for contamination, corrosion, and damage, using a 4-power (maximum) magnification as follows:

(1) Contamination (dust, dirt, moisture, or foreign particles) is not acceptable. If contamination is found, clean interior of connector as outlined in section I.

(2) Corroded contact pins and contact sockets are not acceptable. If corrosion is found, clean interior of connector as outlined in section I. Corrosion-pitted pins and sockets are not acceptable. Contact Rocketdyne Logistics Program Support for disposition.

(3) Cracked or split connector inserts are not acceptable. Contact Rocketdyne Logistics Program Support for disposition.

(4) Broken connector shells and damaged sealing surfaces of connectors are not acceptable. Contact Rocketdyne Logistics Program Support for disposition.

c. On electrical connectors J36 and J119 inspect connector receptacle gasket and dielectric spacer. If gasket is damaged, remove and discard gasket using a No. 10, 11, or 12 crochet needle (one in tool kit 9024994). Reinstall new gasket. If dielectric spacer is damaged, replace spacer as follows:

(1) Remove and discard spacer using a No. 10, 11, or 12 crochet needle (one in tool kit 9024994).

(2) Remove protective film from new spacer.

(3) Install new spacer so that pin designation letters on spacer face outward and letters correspond with letters in receptacle.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

d. Dry plugs and receptacles with a jet of low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A) for 2 minutes minimum. Visually inspect for moisture. If moisture is still present, repeat step.

e. Mate plug and receptacle as follows:

CAUTION

Tools (wrenches, pliers, etc) must not be used for tightening connectors since damage to connectors or components could result.

NOTE

For ease of safetywiring, lockwire MS20995N20 may be inserted in the lockwire hole before mating the connectors.

(1) Carefully aline master keyway with master key.

(2) Faces of plug and receptacle must be parallel.

(3) Carefully start plug into receptacle.

(4) Turn coupling nut clockwise by hand until coupling nut locks on receptacle bayonet pins. (This locking can usually be heard but should be verified by viewing end of bayonet pin in any of three holes located in coupling nut.) Torquing of bayonet-type connectors is not required.

(5) Safetywire connector.

(6) Install thermal protecting boot around connector coupling nut.

(7) Install support clamps and torque screws to 24-30 in-lb.

(8) Make sure receptacle identification number (JXXX number) is stamped adjacent to receptacle. If identification number is missing or not legible, use a rubber stamp with 0.25-inch letters and black ink 24F (The Pannier Corp) and stamp JXXX number adjacent to receptacle.

f. If this procedure is not being performed as a reference from another procedure, refer to section IV for test requirements.

3-32. ELECTRICAL CONTROL ASSEMBLY.

3-33. REMOVING ELECTRICAL CONTROL ASSEMBLY (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-11.)

a. Obtain the following:

(1) Support ST3950166RKL001 (one required) for each igniter cable NA5-27448 installed on engines)

(2) Sequence controller handler 9016789 (required only if ECA is uninsulated of if insulation is to be removed to remove ECA)

(3) Component handler universal lifting sling 9016779 (required only if sequence controller handler is used)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Measure and record pressure in SIC, and if required, perform a leak test as outlined in R-3825-1B.

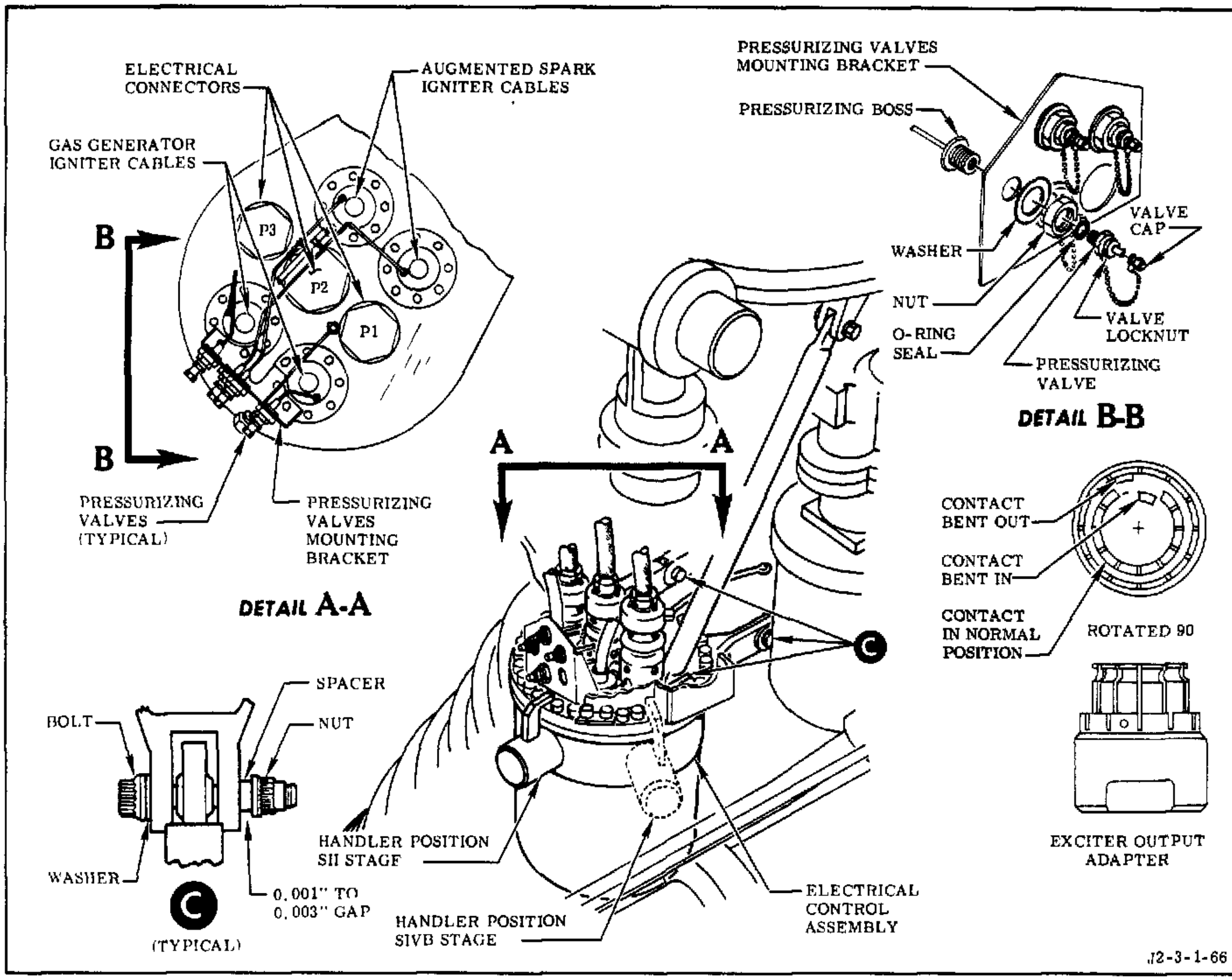


Figure 3-11. Electrical Control Assembly

d. Depressurize SIC by backing off pressurizing valve locknut (figure 3-11) 1/2 to 1 turn and depressing valve core.

e. Remove the 4 pressurizing valves (paragraph 3-245B).

f. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG SIC and remove bracket.

g. Remove remaining bolts and washers that secure GG SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

h. Remove GG SIC from ECA by pulling straight out on bell housings until insulator clears exciter output adapter. Use care to prevent damage to SIC and ECA.

hA. Visually inspect GG SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

CAUTION

Failure to counter frictional forces generated by removing the grommet can dislodge the bushing from the antirotation ring in SIC NA5-27448. A dislodged bushing can prevent pressurization of the SIC.

hB. On SIC NA5-27448 or NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet. On SIC NA5-27448, maintain finger pressure against insulator while removing grommet.

hC. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

i. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

iA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

iB. Install clean protective closure (paragraph 3-258) on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

j. Secure cables to engine.

k. Remove nuts, washers, and screws from support clamps on ASI SIC pressurizing lines.

l. Disconnect electrical connectors (paragraph 3-30) P1, P2, and P3.

m. Remove bolts and washers that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.

- Excessive bending and twisting of SIC can damage the cable bellows.

n. Remove ASI SIC from ECA by pulling straight out on bell housing until insulator clears exciter output adapter. Use care to prevent damage to SIC and ECA.

nA. Visually inspect ASI SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

nB. On SIC NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet.

o. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of foreign material.

CAUTION

Incorrect installation of desiccant can displace desiccant retainer, causing damage to the SIC connector.

oA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

oB. Install clean protective closure (paragraph 3-258) on ASI SIC bell housing, and ECA.

p. Secure cables to engine.

q. Disconnect ground cable from bracket on thrust chamber.

r. If ECA is not insulated, install sequence controller handler on ECA. If ECA is insulated, remove sufficient insulation (paragraph 3-155) to permit installation of handler, or provide a means of support that will not damage insulation. With engine in handler, install sequence controller handler with socket adapter up and vertical. With engine in unstacked stage, install handler, oriented to provide a convenient handle with universal lifting sling installed.

CAUTION

Sharp, thin, and/or pointed objects, such as fingernails, small straps, or line used to support the insulated ECA, can damage the insulation.

s. If engine is in engine handler and sequence controller handler is installed, attach universal lifting sling to handler and overhead hoist to universal lifting sling. If engine is in unstacked stage and sequence controller handler is installed, universal lifting sling may be attached to handler as an aid in supporting weight of ECA.

t. Support weight of ECA (approximately 58 pounds) by use of overhead hoist or a suitable alternate method, and remove nuts, spacers, washers, and bolts that secure ECA to thrust chamber and rod.

u. Make sure ECA is free of engine, then move ECA clear of engine.

v. If it is expected that more than 7 days will elapse before reinstallation, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas on ECA where protective finish has been removed.

3-34. REMOVING ELECTRICAL CONTROL ASSEMBLY (STACKED SII STAGE). (See figure 3-11.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment..

a. Obtain the following: (Items 2 through 5 are not required if launch tower umbilical arm is to be used for transporting component from stage.)

(1) Sequence controller handler 9016789

(2) Component handler universal lifting sling 9016779

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Component handling cart 9026253-11 from engine components installer set 9026251

(7) Ramps 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(8) Support ST3950166RKL001 (one required for each igniter cable NA5-27448 installed on engine)

b. Assemble track (section V) around engine from which ECA is to be removed. Install turntable with controls leading, and position hoist at track station 7.5 for engine positions 1 through 4, and track station 25 for engine position 5.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Measure and record pressure in igniter cables, and if required, perform a leak test as outlined in R-3825-1B.

e. Depressurize igniter cable by backing off pressurizing valve locknut (figure 3-11) 1/2 to 1 turn and depressing valve core.

f. Remove the 4 pressurizing valves (paragraph 3-245B).

CAUTION

Care must be taken throughout the remainder of this procedure not to bend the igniter cable pressurizing tubes since damage can result.

g. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG igniter cables, and remove bracket.

h. Remove remaining bolts and washers that secure GG SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

i. Remove GG SIC from ECA by pulling straight out on bell housings until insulator clears exciter output adapter. Use care to prevent damage to SIC and ECA.

iA. Visually inspect GG SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

CAUTION

Failure to counter frictional forces generated by removing the grommet can dislodge the bushing from the antirotation ring in SIC NA5-27448. A dislodged bushing can prevent pressurization of the SIC.

iB. On SIC NA5-27448 or NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet. On SIC NA5-27448, maintain finger pressure against insulator while removing grommet.

iC. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

j. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

jA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

jB. Install clean protective closure (paragraph 3-258) on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

k. Secure cables to engine.

l. Remove nuts, washers, and screws from support clamps on ASI SIC pressurizing lines.

m. Disconnect electrical connectors (paragraph 3-30) P1, P2, and P3.

n. Remove bolts and washers that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.

o. Remove ASI SIC from ECA by pulling straight out on bell housings until insulator clears exciter output adapter. Use care to prevent damage to SIC and ECA.

oA. Visually inspect ASI SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

oB. On SIC NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet.

p. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foréign material.

CAUTION

Incorrect installation of desiccant can displace desiccant retainer, causing damage to the SIC connector.

pA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

pB. Install clean protective closure (paragraph 3-258) on ASI SIC bell housing, and ECA.

q. Secure cables to engine.

r. Disconnect ground cable from bracket on thrust chamber.

s. Install sequence controller handler on ECA. (See figure 3-11.) If ECA is insulated, remove enough insulation (paragraph 3-155) to permit installation of handler. Wrap handler strap around package and secure with ball-lock pin.

t. Attach hoist to handler, securing hoist to handler with ball-lock pin.

u. Support weight of ECA with hoist, making sure side load does not exist on ECA, and remove nuts, spacers, washers, and bolts that secure ECA to thrust chamber and rod.

v. Make sure ECA is free of engine; then move ECA clear of engine.

w. If it is expected that more than 7 days will elapse before reinstallation, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas on ECA where protective finish has been removed.

x. If launch tower umbilical arm is used to transport component from stage, omit steps y through ab.

y. Using hoist, transfer ECA from engine and place on protective pad.

z. Attach component handler universal lifting sling to handler on ECA.

aa. Install chain-hoist on hoist.

ab. Connect chain-hoist hook to component handler universal lifting sling and raise ECA with chain-hoist.

ac. Transport ECA through stage access door, and lower control assembly into component handling cart. Disengage component from hoist, manually lifting component if necessary to disengage.

3-35. REMOVING ELECTRICAL CONTROL ASSEMBLY (STACKED SIVB STAGE). (See figure 3-11.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. *Obtain the following:*

(1) Sequence controller handler 9016789.

(2) Extension 9027080 from Engine Components Installer G4072.

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072.

(4) Component handler universal lifting sling 9016779.

(5) Component handling cart 9026253-11 from engine components installer set 9026252.

(6) Ramps 9026255 (2 required) and 9026255-11 from engine components installer set 9026252 (required for use on launch tower umbilical arm).

(7) Support ST3950166RKL001 (one required for each SIC NA5-27448 installed on engine).

b. Assemble track (section V) for ECA removal. Install turntable with controls leading.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Measure pressure in SIC as outlined in R-3825-1B.

e. Depressurize SIC by backing off pressurizing valve locknut (figure 3-11) 1/2 to 1 turn and depressing valve core.

f. Remove the 4 pressurizing valves (paragraph 3-245B).

CAUTION

Care must be taken throughout this procedure to prevent damaging the SIC pressurizing lines.

g. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG SIC and remove bracket.

h. Remove remaining bolts and washers that secure GG SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

i. Remove GG SIC from ECA by pulling straight out on bell housings until insulator clears exciter output adapter. Use care to prevent damage to SIC.

iA. Visually inspect GG SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

CAUTION

Failure to counter frictional forces generated by removing the grommet can dislodge the bushing from the antirotation ring in SIC NA5-27448. A dislodged bushing can prevent pressurization of the SIC.

iB. On SIC NA5-27448 or NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet. On SIC NA5-27448, maintain finger pressure against insulator while removing grommet.

iC. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

j. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

jA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

jB. Install clean protective closure (paragraph 3-258) on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

k. Secure cables to engine.

l. Remove nuts, washers, and screws from support clamps on ASI SIC pressurizing lines.

m. Disconnect electrical connectors (paragraph 3-30) P1, P2, and P3.

n. Remove bolts and washers that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.

o. Remove ASI SIC from ECA by pulling straight out on bell housings until insulator clears exciter output adapter. Use care to prevent damage to SIC and ECA.

oA. Visually inspect ASI SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

oB. On SIC NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet.

p. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

CAUTION

Incorrect installation of desiccant can displace desiccant retainer, causing damage to the SIC connector.

pA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

pB. Install clean protective closure (paragraph 3-258) on ASI SIC bell housing and ECA.

q. Secure cables to engine.

r. Disconnect ground cable from bracket on thrust chamber.

s. Install sleeve, extension, and handler on hoist. (See figure 3-6, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

t. Manipulate hoist to lower handler through opening in which lower work platform is installed and orient handler with ECA.

u. Install sequence controller handler on ECA. (See figure 3-11.) If ECA is insulated, remove enough insulation (paragraph 3-155) to permit installation of handler. Wrap handler strap around package and secure with ball-lock pin.

CAUTION

Whenever the turnbuckle is adjusted in the following procedure, a minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

v. Support weight of ECA with hoist, making sure side load does not exist on ECA, and remove nuts, spacers, washers, and bolts that secure ECA to thrust chamber and rod.

w. Make sure ECA is free of engine; then, with hoist and extension turnbuckle, move ECA clear of engine and through opening in which lower work platform is installed. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in raising component through stage work deck.

NOTE

Because the remoteness of the hoist operator from the ECA and deflection of the hoisting equipment, it is recommended that a technician guide the assembly and otherwise assist the hoist operator.

x. If it is expected that more than 7 days will elapse before reinstallation, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas on ECA where protective finish has been removed.

y. Using hoist, move ECA to an accessible area near stage access door.

z. Remove handler (with ECA attached) from hoist and temporarily place on protective pad. Install component handler universal lifting sling on handler and secure ball-lock pin.

aa. Using lifting eye on sling, manually transport ECA through stage access door and place control assembly into component handling cart.

NOTE

The combined weight of ECA, sling, and handler is approximately 70 pounds.

3-36. INSTALLING ELECTRICAL CONTROL ASSEMBLY (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-11.)

a. If ECA is being replaced, verify that ECA preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain the following:

(1) Sequence controller handler 9016789 (required only if ECA is uninsulated or if insulation is to be removed to install ECA)

(2) Component handler universal lifting sling 9016779 (required only if sequence controller handler is used)

(3) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure ECA, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

cA. Visually inspect SIC insulators and ECA exciter ceramic insulators for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found on a cable insulator, replace insulator (R-3825-3, Volume II). If a breakdown path is found on an ECA exciter insulator, replace ECA (paragraph 3-32).

d. Check each exciter output adapter for bent or broken contacts as follows: (See figure 3-11.)

(1) Contacts bent less than 0.070 inch from normal position are acceptable; do not attempt to straighten contacts.

(2) Contacts bent 0.070 inch or more from normal position must be broken off (bend contact back and forth) and discarded.

(3) Adapters that have no more than 2 broken contacts (any position) are acceptable.

(4) If any one adapter has more than 2 broken contacts, replace ECA.

e. If ECA is not insulated, install sequence controller handler on ECA. If ECA is insulated, remove sufficient insulation (paragraph 3-155) to permit installation of handler, or provide a means of support that will not damage insulation. If sequence controller handler is to be installed and engine is in handler, install handler in position shown for SII stage (figure 3-11). If engine is in unstacked stage, install handler oriented to provide a convenient handle with universal lifting sling installed.

CAUTION

Sharp, thin, and/or pointed objects, such as fingernails, small straps, or line used to support the insulated ECA, can damage the insulation.

f. If ECA is to be installed on an engine in an engine handler and sequence controller handler is installed, attach universal lifting sling to handler and overhead hoist to universal lifting sling. If engine is in unstacked stage and sequence controller handler is installed, universal lifting sling may be attached to handler as an aid in supporting weight of ECA (58 pounds).

g. Lift ECA into position on engine, and secure ECA to brackets and rod with washers, bolt, spacers, and nuts. Tighten nuts until a 0.001 to 0.003 inch gap exists between nut and spacer. (See figure 3-11.)

h. Remove sling and handler from ECA.

i. Remove protective closures from SIC bell housing and exciter output adapter, and support from SIC NA5-27448, as cables are installed.

j. Using a small wire brush or 320-grit (or finer) abrasive cloth or paper, remove protective finishes and foreign matter from bonding surfaces of ground cable, 4 SIC attaching bolts, and bonding surface around 4 boltholes, 90 degrees apart, on each SIC bell housing. Take care not to damage sealing surfaces.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

k. Clean bonding and mating surfaces of SIC bell housings, ECA, bell housing attaching bolts, and ground cable with a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602).

l. Connect ground cable to bracket on thrust chamber with screw and washer. Torque screw to 27-33 in-lb.

m. Lubricate (Method A, section I) bolts that attach ASI cable to ECA with sealing and anti-seize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

n. Lubricate (Method J, section I) ASI cable O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

o. Install each ASI SIC on ECA as follows:

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

(1) On SIC NA5-27448T1, wearing clean nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

(2) Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of the output adapter fingers.

(3) Center SIC insulator over exciter output adapter with pressurizing line boss positioned between exciter output adapters G3 and G4, and press bell housing down so that insulator goes straight into exciter output adapter.

(4) Install bolts, with washers, in igniter cable bell housing. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding.

p. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire. To minimize the need to disassemble due to ASI SIC leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedure.)

q. Install support clamps on ASI SIC pressurizing lines with bolts, washers, and nuts. Torque nuts to 24-30 in-lb.

r. Connect electrical connectors (paragraph 3-31) P1, P2, and P3.

s. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

t. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

u. Install each GG SIC on ECA as follows:

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

(1) Wearing clean nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of the output adapter fingers.

(2) Center SIC insulator over exciter output adapter with pressurizing line alined with pressurizing lines from bell housings G1 and G2, and press bell housing down so that insulator goes straight into exciter output adapter.

(3) Install 2 bolts, with washers, fingertight into holes that are in line with centers of bell housings G3 and G4. If these holes are cleaned for bonding, make sure bolts cleaned for bonding are used.

v. Position bracket on igniter cable pressurizing line bosses and secure bracket and igniter cable bell housing to ECA with bolts. Tighten bolts fingertight. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding.

w. Install remaining bolts and washers in igniter cable bell housing. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

x. Cross-torque bolts that secure igniter cables to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire.

y. Lubricate (Method A, section I) exterior threads of pressurizing bosses with lubricant grease RB0140-012 (Rocketdyne).

z. Install washers and nuts on igniter cable pressurizing bosses. Hold bosses to prevent rotation, and torque nuts to 290 ±10 in-lb and safetywire.

aa. Install the 4 pressurizing valves (paragraph 3-245C).

ab. (Deleted)

ac. Using milliohmmeter, measure resistance between ECA and thrust chamber. Resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded junctures if thrust chamber and ECA structure is suspect for excessive resistance.

ad. Using milliohmmeter, measure resistance between any one of the 4 bonded bolts that secure each SIC bell housing to ECA. Resistance must not exceed 10 milliohms. Measurement may be made as close as possible to bonded junctures if bolt or ECA structure is suspect for excessive resistance. Complete step ae within 24 hours of completion of resistance checks (steps ac and ad); otherwise repeat steps ac and ad.

ae. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonded areas.

af. Leak-test and pressurize igniter cables. (Refer to R-3825-1B.)

ag. Refer to section IV for test procedures.

ah. On engines incorporating MD224 change, insulate ECA. (Refer to paragraph 3-165.)

3-37. INSTALLING ELECTRICAL CONTROL ASSEMBLY (STACKED SII STAGE). (See figure 3-11.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. If ECA is being replaced, verify that ECA preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain the following: (Items 5 through 8 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Sequence controller handler 9016789

(2) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent.

(3) Component handler cart 9026253-11 from engine components installer set 9026251.

(4) Ramps 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(5) Component handler universal lifting sling 9016779

(6) Chain-hoist 9027095 from engine components installer set 9026251

(7) Universal joint S8 from engine components installer set 9026251

(8) Extension bar SX-24 from engine components installer set 9026251.

b. Using component handling cart, transport ECA to stage.

c. If ECA is insulated, remove (paragraph 3-155) all or sufficient insulation to permit installation of sequence controller handler.

d. Install sequence controller handler on ECA. Wrap handler straps around ECA and secure with ball-lock pin. (See figure 3-11 for proper location of handler.)

NOTE

If the launch tower umbilical arm is used to transport the component to the stage, omit steps e through j.

e. Attach component handler universal lifting sling to handler on ECA.

f. Attach chain-hoist to hoist.

g. Using universal joint, extension bar, and a suitable tool to operate chain-hoist, manipulate hoist and chain-hoist to attach hook of chain-hoist to lifting sling on handler.

h. Raise ECA with chain-hoist and hoist and remove ECA into stage.

i. Lower ECA onto a protective pad and disengage chain-hoist hook. To prevent the need to manually lift ECA when reattaching ECA to hoist, lay ECA on a platform so as to position hoist adapter on sequence controller handler not more than 2. 5 inches below centerline of track.

j. Retract chain fully into chain-hoist, and remove chain-hoist from hoist.

k. Attach hoist to sequence controller handler, manually lifting ECA if necessary to effect connection.

l. Move hoist to track station 7. 5 if ECA is being installed on engine in engine positions 1 through 4, or track station 25 if ECA is being installed on engine in engine position 5.

m. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

n. Remove protective closures (paragraph 3-257). Make sure ECA, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

nA. Visually inspect SIC insulators and ECA exciter ceramic insulators for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found on a cable insulator, replace insulator (R-3825-3, Volume II). If a breakdown path is found on an ECA exciter insulator, replace ECA (paragraph 3-32).

o. Check each exciter output adapter for bent or broken contacts as follows: (See figure 3-11.)

(1) Contacts bent less than 0. 070 inch from normal position are acceptable; do not attempt to straighten.

(2) Contacts bent 0. 070 inch or more from normal position must be broken off (bend contact back and forth) and discarded.

(3) Adapters that have no more than 2 broken contacts (any position) are acceptable.

(4) If any one adapter has more than 2 broken contacts, replace ECA.

p. Manipulate hoist to position ECA on engine and secure ECA to brackets and rod with washers, bolts, spacers, and nuts. Tighten nuts until a 0. 001 to 0. 003 inch gap exists between nut and spacer. (See figure 3-11.)

q. Remove handler from ECA.

r. Disassemble track. (Refer to section V.)

s. Using a small wire brush or 320-grit (or finer) abrasive cloth or paper, remove protective finishes and foreign matter from bonding surfaces of ground cable, 4 igniter cable

attaching bolts, and bonding surface around 4 boltholes, 90 degrees apart, on each SIC bell housing. Take care not to damage sealing surfaces.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

t. Clean bonding and mating surfaces of SIC bell housings, ECA, bell housing attach bolts, and ground cable with a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602).

u. Connect ground cable to bracket on thrust chamber with screw and washers. Torque screw to 27-33 in-lb.

v. Lubricate (Method A, section I) bolts that attach ASI cable to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

w. Lubricate (Method J, section I) ASI cable O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

x. Install each ASI SIC on ECA as follows:

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

(1) On SIC NA5-27448T1, wearing clean nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

(2) Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of the output adapter fingers.

(3) Center SIC insulator over exciter output adapter with pressurizing line boss positioned between exciter output adapters G3 and G4, and press bell housing down so that insulator goes straight into exciter output adapter.

(4) Install bolts, with washers, in igniter cable bell housing. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding.

y. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire. To minimize the need to disassemble due to ASI SIC leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedure.)

z. Install support clamps on ASI SIC pressurizing lines with bolts, washers, and nuts. Torque nuts to 24-30 in-lb.

aa. Connect electrical connectors (paragraph 3-31) P1, P2, and P3.

ab. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

ac. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

ad. Install each GG SIC on ECA as follows:

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

(1) Wearing clean nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of the output adapter fingers.

(2) Center SIC insulator over exciter output adapter with pressurizing line alined with pressurizing lines from bell housings G1 and G2, and press bell housing down so that insulator goes straight into exciter output adapter.

(3) Install 2 bolts, with washers, fingertight into holes that are in line with centers of bell housings G3 and G4. If these holes are cleaned for bonding, make sure bolts cleaned for bonding are used.

ae. Position bracket on igniter cable pressurizing line bosses and secure bracket and igniter cable bell housing to ECA with bolts. Tighten bolts fingertight. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding.

af. Install remaining bolts and washers in igniter cable bell housing. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

ag. Cross-torque bolts that secure igniter cables to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire.

ah. Lubricate (Method A, section I) exterior threads of pressurizing bosses with lubricant grease RB0140-012 (Rocketdyne).

ai. Install washers and nuts on igniter cable pressurizing bosses. Hold bosses to prevent rotation and torque nuts to 290 ±10 in-lb and safetywire.

aj. Install the 4 pressurizing valves (paragraph 3-245C).

ak. (Deleted)

al. Using milliohmmeter, measure resistance between ECA and thrust chamber. Resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded junctures if thrust chamber and ECA structure is suspect for excessive resistance.

am. Using milliohmmeter, measure resistance between any one of the 4 bonded bolts that secure each SIC bell housing to ECA. Resistance must not exceed 10 milliohms. Measurement may be made as close as possible to bonded junctures if bolt or ECA structure is suspect for excessive resistance. Complete step an within 24 hours of completion of resistance checks (steps al and am); otherwise repeat steps al and am.

an. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonded areas.

ao. Leak-test and pressurize igniter cables. (Refer to R-3825-1B.)

ap. Refer to section IV for test requirements.

aq. On engines incorporating MD224 change, insulate ECA. (Refer to paragraph $\overline{3-1}65$.)

3-38. INSTALLING ELECTRICAL CONTROL ASSEMBLY (STACKED SIVB STAGE). (See figure 3-11.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. If ECA is being replaced, verify that ECA preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain the following:

(1) Sequence controller handler 9016789

(2) Extension 9027080 from Engine Components Installer G4072

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072

(4) Component handler universal lifting sling 9016779

(5) Component handling cart 9026253-11 from engine components installer set 9026252

(6) Ramps 9026255 (2 required) and 9026255-11 from engine components installer set 9026252 (required for use on launch umbilical arm)

(7) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

b. Using component handling cart, transport ECA to stage.

c. Install sequence controller handler on ECA. Wrap handler straps around ECA and secure with ball-lock pin. (See figure 3-11 for proper location of handler.)

d. Attach component handler universal lifting sling to handler on ECA.

e. Using universal lifting sling as a handle, manually transfer ECA into stage and lay ECA on a protective pad in stage.

f. Remove universal lifting sling from handler.

g. Install sleeve and extension on hoist. (See figure 3-6, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series vehicle) from turnbuckle. Secure with ball-lock pin.

h. Attach hoist to sequence controller handler, manually lifting ECA if necessary to effect connection.

i. Move hoist to proximity of ECA installation area on engine.

j. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

k. Remove protective closures (paragraph 3-257). Make sure ECA, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

kA. Visually inspect SIC insulators and ECA exciter ceramic insulators for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found on a cable insulator, replace insulator (R-3825-3, Volume II). If a breakdown path is found on an ECA exciter insulator, replace ECA (paragraph 3-32).

l. Check each exciter output adapter for bent or broken contacts as follows: (See figure 3-11.)

(1) Contacts bent less than 0.070 inch from normal position are acceptable; do not attempt to straighten.

(2) Contacts bent 0.070 inch or more from normal position must be broken off (bend contact back and forth) and discarded.

(3) Adapters that have no more than 2 broken contacts (any position) are acceptable.

(4) If any one adapter has more than 2 broken contacts, replace ECA.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

m. Using hoist, lower ECA through opening in which lower work platform is installed, position ECA on engine, and secure ECA to brackets and rod with washers, bolts, spacers, and nuts. Torque nuts until a 0.001 to 0.003 inch gap exists between nut and spacer. (See figure 3-11.)

NOTE

Extending the turnbuckle to its maximum length (one thread evident in the adjusting barrel) will effect a narrow profile to aid in lowering the component through the stage work deck.

- Because of the remoteness of the hoist operator from the ECA installation area and deflection of hoisting equipment, it is recommended that a technician guide the ECA and otherwise assist the hoist operator.

n. Remove handler from ECA.

o. Disassemble track. (Refer to section V.)

p. Using a small wire brush or 320-grit (or finer) abrasive cloth or paper, remove protective finishes and foreign matter from bonding surfaces of ground cable, 4 igniter cable attaching bolts, and bonding surface around 4 boltholes, 90 degrees apart, on each igniter cable bell housing. Take care not to damage sealing surfaces.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

q. Clean bonding and mating surfaces of igniter cable bell housings, ECA, bell housing attach bolts, and ground cable with a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602).

r. Connect ground cable to bracket on thrust chamber with screw and washers. Torque screw to 27-33 in-lb.

s. Lubricate (Method A, section I) bolts that attach ASI cable to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

t. Lubricate (Method J, section I) ASI cable O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

u. Install each ASI SIC on ECA as follows:

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

(1) On SIC NA5-27448T1, wearing clean nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

(2) Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of foreign material.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of the output adapter fingers.

(3) Center SIC insulator over exciter output adapter with pressurizing line boss positioned between exciter output adapters G3 and G4, and press bell housing down so that insulator goes straight into exciter output adapter.

(4) Install bolts, with washers, in igniter cable bell housing. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding.

v. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire. To minimize the need to disassemble due to ASI SIC leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedure.)

w. Install support clamps on ASI SIC pressurizing lines with bolts, washers, and nuts. Torque nuts to 24-30 in-lb.

x. Connect electrical connectors (paragraph 3-31) P1, P2, and P3.

y. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

z. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

aa. Install each GG SIC on ECA as follows:

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

(1) Wearing clean nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of the output adapter fingers.

(2) Center SIC insulator over exciter output adapter with pressurizing line alined with pressurizing lines from bell housings G1 and G2, and press bell housing down so that insulator goes straight into exciter output adapter.

(3) Install 2 bolts, with washers, fingertight into holes that are in line with centers of bell housings G3 and G4. If these holes are cleaned for bonding, make sure bolts cleaned for bonding are used.

ab. Position bracket on SIC pressurizing line bosses and secure bracket and SIC bell housing to ECA with bolts, Tighten bolts fingertight. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding.

ac. Install remaining bolts and washers in SIC bell housing. Make sure bolts cleaned for bonding are installed in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

ad. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire.

ae. Lubricate (Method A, section I) exterior threads of pressurizing bosses with lubricant grease RB0140-012 (Rocketdyne).

af. Install washers and nuts on igniter cable pressurizing bosses. Hold bosses to prevent rotation and torque nuts to 290 ±10 in-lb and safetywire.

ag. Install the 4 pressurizing valves (paragraph 3-245C).

ah. (Deleted)

ai. Using milliohmmeter, measure resistance between ECA and thrust chamber. Resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded junctures if thrust chamber and ECA structure is suspect for excessive resistance.

aj. Using milliohmmeter, measure resistance between any one of the 4 bonded bolts that secure each SIC bell housing to ECA. Resistance must not exceed 10 milliohms. Measurement may be made as close as possible to bonded junctures if bolt or ECA structure is suspect for excessive resistance. Complete step ak within 24 hours of completion of resistance checks (steps ai and aj); otherwise repeat steps ai and aj.

ak. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonded areas.

al. Leak-test and pressurize igniter cables. (Refer to R-3825-1B.)

am. Refer to section IV for test requirements.

3-39. FAST-SHUTDOWN VALVE.

3-40. REMOVING FAST-SHUTDOWN VALVE. (See figure 3-12.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Cut fast-shutdown valve control line. (Refer to section VI for tube-cutting requirements.) Protect open lines.

c. Remove bolts that secure inlet line to fast-shutdown valve, and remove seal. Protect open ports and sealing surfaces.

d. Remove vent port check valve (paragraph 3-308).

e. Remove bolts and washers that secure fast-shutdown valve to bracket, and remove valve and seal.

f. Remove all protective material from fast-shutdown valve and engine ports; install clean protective closures (paragraph 3-258).

3-41. INSTALLING FAST-SHUTDOWN VALVE. (See figure 3-12.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure fast-shutdown valve, engine mating connections, threads in parent metal and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Position fast-shutdown valve on engine, and remove protective material from valve and mating flange.

d. Install seal, and secure fast-shutdown valve and seal to bracket with bolts and washers. Torque bolts to 81-89 in-lb.

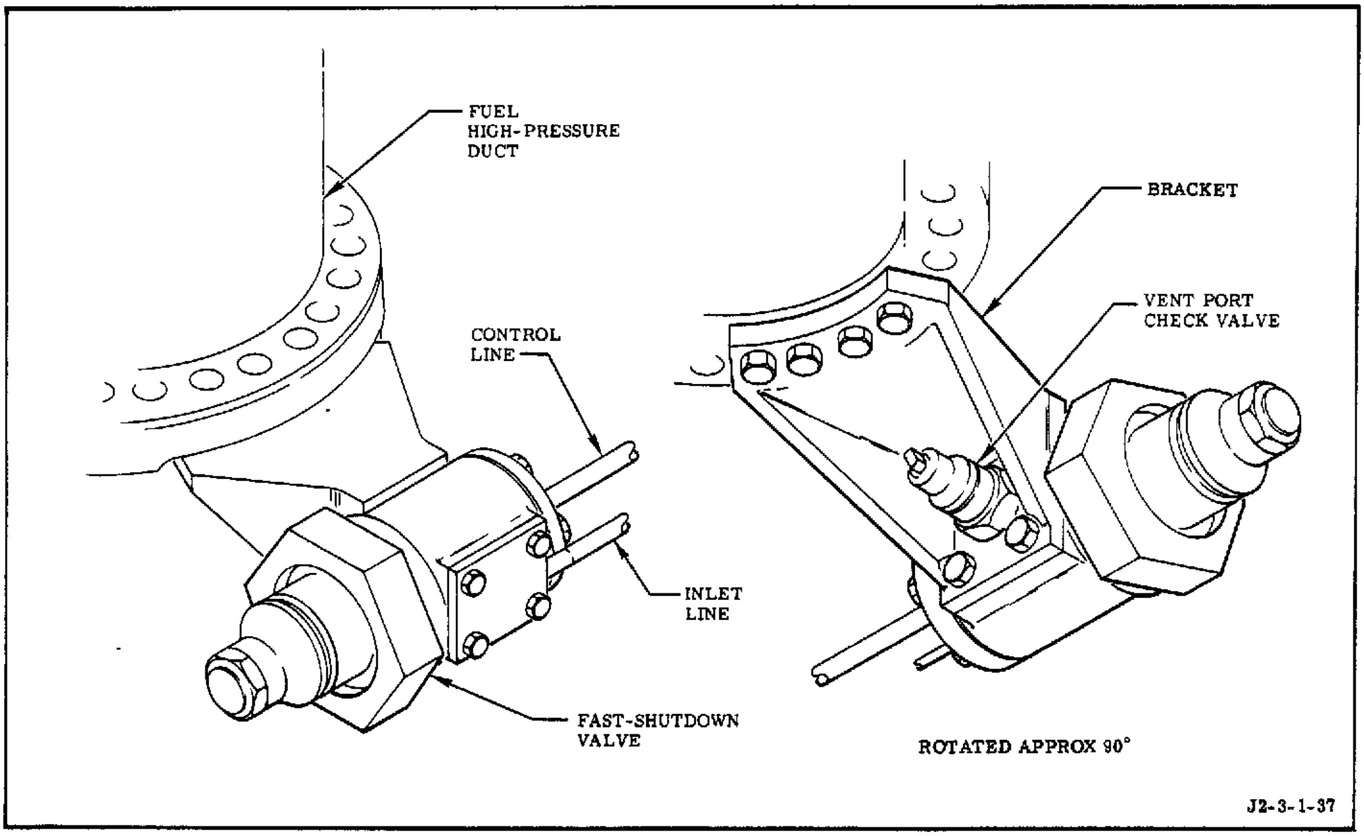


Figure 3-12. Fast-Shutdown Valve

e. Install vent port check valve (paragraph 3-309).

f. Remove protective material from fast-shutdown valve inlet port and line flange. Install seal, bolts, and washers. Torque bolts to 41-45 in-lb and safetywire.

g. Remove protective material from control line; then weld control line. (Refer to section VI for welding requirements.)

h. On engines incorporating MD292 change, if fast-shutdown valve is replaced, install insulation (paragraph 3-157).

i. Refer to section IV for test requirements.

3-42. <u>FUEL BLEED VALVE</u>.

3-43. REMOVING FUEL BLEED VALVE. (See figure 3-13.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connectors (paragraph 3-30) P133 and P158.

c. Remove bolts, washers, and bracket that secure control line to fuel bleed valve; remove seal, and protect open ports and sealing surfaces.

d. Remove bolts, washers, and bracket that secure fuel bleed line to fuel bleed valve; remove seal, and protect open ports and sealing flanges.

e. Remove bolts that secure fuel bleed valve to GG fuel line; remove seal, and protect open ports and sealing flanges.

f. Carefully remove valve from engine.

g. Remove all protective material from fuel bleed valve and engine ports; install clean protective closures (paragraph 3-258).

h. If fuel bleed valve is to be replaced, remove seal bleed plugs, temperature transducer, bracket, lug and plugs from fuel bleed valve capped port (GF5), if applicable. Retain parts for installation on new valve. Install clean protective closures (paragraph 3-258) on open ports.

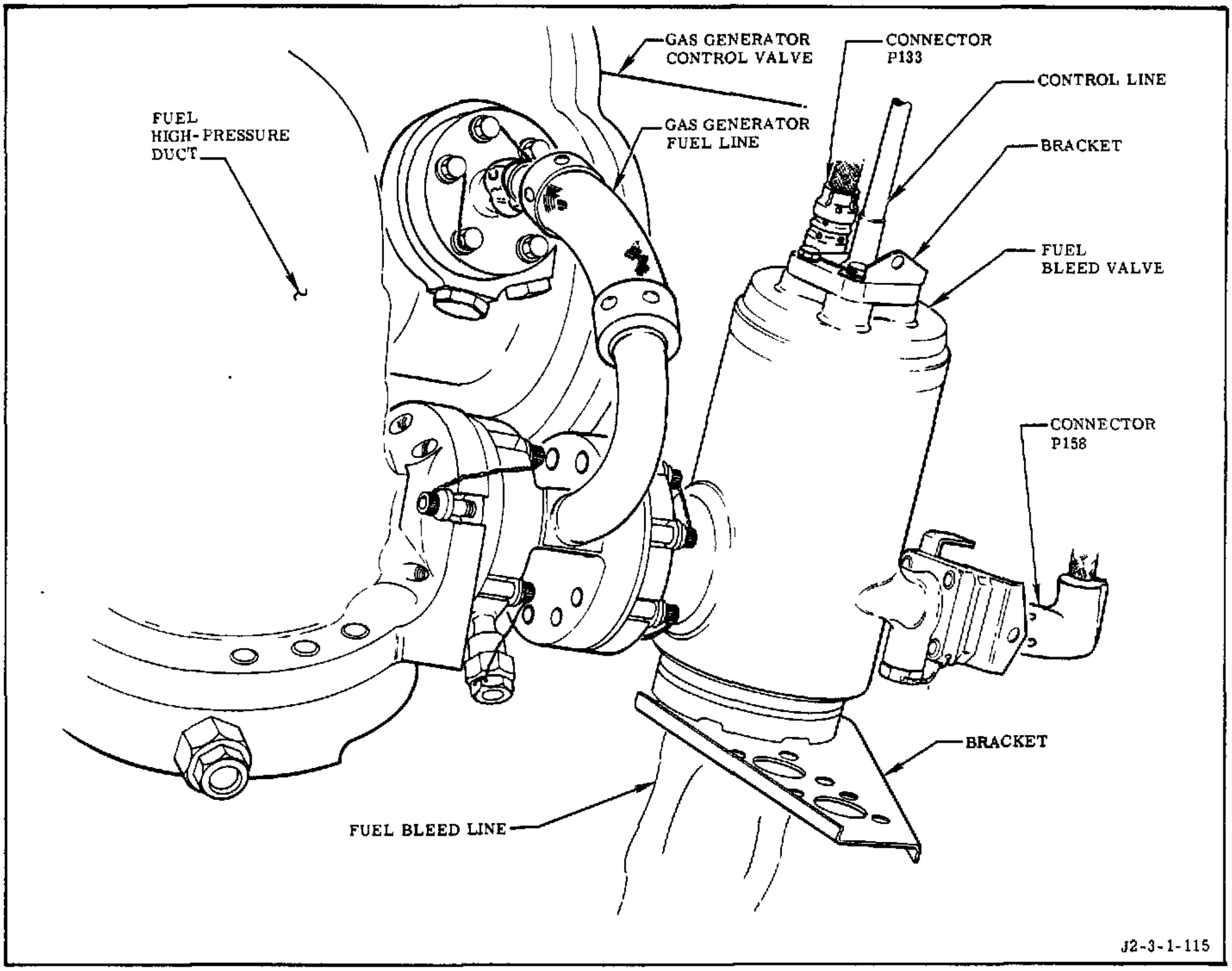


Figure 3-13. Fuel Bleed Valve and Gas Generator Fuel Line

3-44. INSTALLING FUEL BLEED VALVE. (See figure 3-13.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure bleed valve, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. If fuel bleed valve is to be replaced, proceed to step d. If fuel bleed valve is to be reinstalled, proceed to step f.

d. Remove protective material from seal bleed plug port, and install seal bleed plug (removed from old bleed valve) and seal. Tighten seal fingertight.

NOTE

The bleed plug will be removed during post-maintenance leak test. Following leak test, bleed plugs will be reinstalled and torqued to 22-28 in-lb and safetywired.

e. Remove protective material from transducer port on bleed valve, and install transducer as follows:

(1) Install seal and transducer (transducer removed from old bleed valve) on bleed valve; position transducer so key in transducer is alined with keyway in connector P158.

(2) Position brackets, and safetywire lug on transducer; secure brackets, lug, transducer, and seal to bleed valve with bolts and washers. Torque bolts to 48-53 in-lb and safetywire.

eA. If applicable, remove protective material from fuel bleed valve capped port (GF5) and install plugs and seals. Torque larger plug to 68-72 in-lb and smaller plug to 22-28 in-lb. Safetywire plugs.

f. Position fuel bleed valve on engine and remove protective material from GG fuel line and mating port on bleed valve. Install seal, and secure valve and seal to GG fuel line with bolts and washers. Torque bolts to 143-157 in-lb and safetywire.

g. Remove protective material from fuel bleed line and bleed valve mating port. Install and secure seal, bracket, and bleed line to bleed valve with bolts and washers. Torque bolts to 30-40 in-lb and safetywire.

h. Remove protective material from control line and mating port on bleed valve. Install and secure seal, bracket, and control line to bleed valve with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

i. Connect electrical connectors (paragraph 3-31) P133 and P158.

j. Refer to section IV for test requirements.

3-45. FUEL BLEED LINE.

3-46. REMOVING FUEL BLEED LINE. (See figure 3-14.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove fuel bleed line flange bolts and washers at bleed valve. (See figure 3-14, view A and detail A.) Leave bracket attached to connectors J180 and J163.

c. Remove bolts, washers, and clamp blocks from bracket at fuel turbopump flange. (See figure 3-14, view A.)

d. Remove screws, washers, nuts, and clamp from fuel bleed line where attached to oxidizer tank pressurization line. (See figure 3-14, view B.)

e. Remove all screws, washers, nuts, and clamps from fuel bleed line that are used to support tubing and harnesses. Leave clamps attached to tubes and harnesses to maintain clamping location.

eA. On engines incorporating MD358 change, remove insulation (paragraph 3-47B).

f. Remove bolts, washers, and channel that secure lines weld bracket to support. (See figure 3-14, view C.)

g. Remove screws that hold oxidizer bleed line, oxidizer tank pressurization, fuel bleed line, and fuel tank pressurization line to front and rear bar assembly; then remove the 2 bars. (See figure 3-14, view D.)

h. On installed engines, remove fuel bleed line flange bolts from customer connect interface panel using Stage Contractor procedures. Protect open ports and sealing surfaces.

i. Remove fuel bleed line from engine.

j. If fuel bleed line is to be replaced, remove bleed plug from leak-test port at fuel bleed valve flange and remove plug from 1/4-inch-OD tube nut. Protect open ports and sealing surfaces.

k. Install clean protective closures (paragraph 3-258).

3-47. INSTALLING FUEL BLEED LINE. (See figure 3-14.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure fuel bleed line, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Remove protective material from fuel bleed line and fuel bleed valve mating flanges. Position line on engine and install flange bolts, seal, washers, and bracket at fuel bleed valve. (See figure 3-14, view A and detail A.) Torque bolts to 30-40 in-lb and safetywire.

d. On installed engine, remove protective material from fuel bleed line flange and customer connect interface panel, and install bolts, washers, and seal using Stage Contractor procedures.

e. Install bolts, washers, spacers, and channel at line weld bracket. (See figure 3-14, view C.) Torque bolts to 55-75 in-lb.

eA. Install 2 bar assemblies using screws, washers, and nuts. Do not torque nuts at this time. (See figure 3-14, view D.)

f. Install bolts, washers, and clamp blocks on fuel bleed line at fuel turbopump flange. (See figure 3-14, view A.) Torque bolts to 60-80 in-lb.

g. Install screw and clamp on bracket to attach fuel bleed line to oxidizer tank pressurization line. (See figure 3-14, view B.) Torque screw to 24-32 in-lb.

h. Install all clamps on fuel bleed line that support tubing and harnesses. Torque screws to 24-32 in-lb.

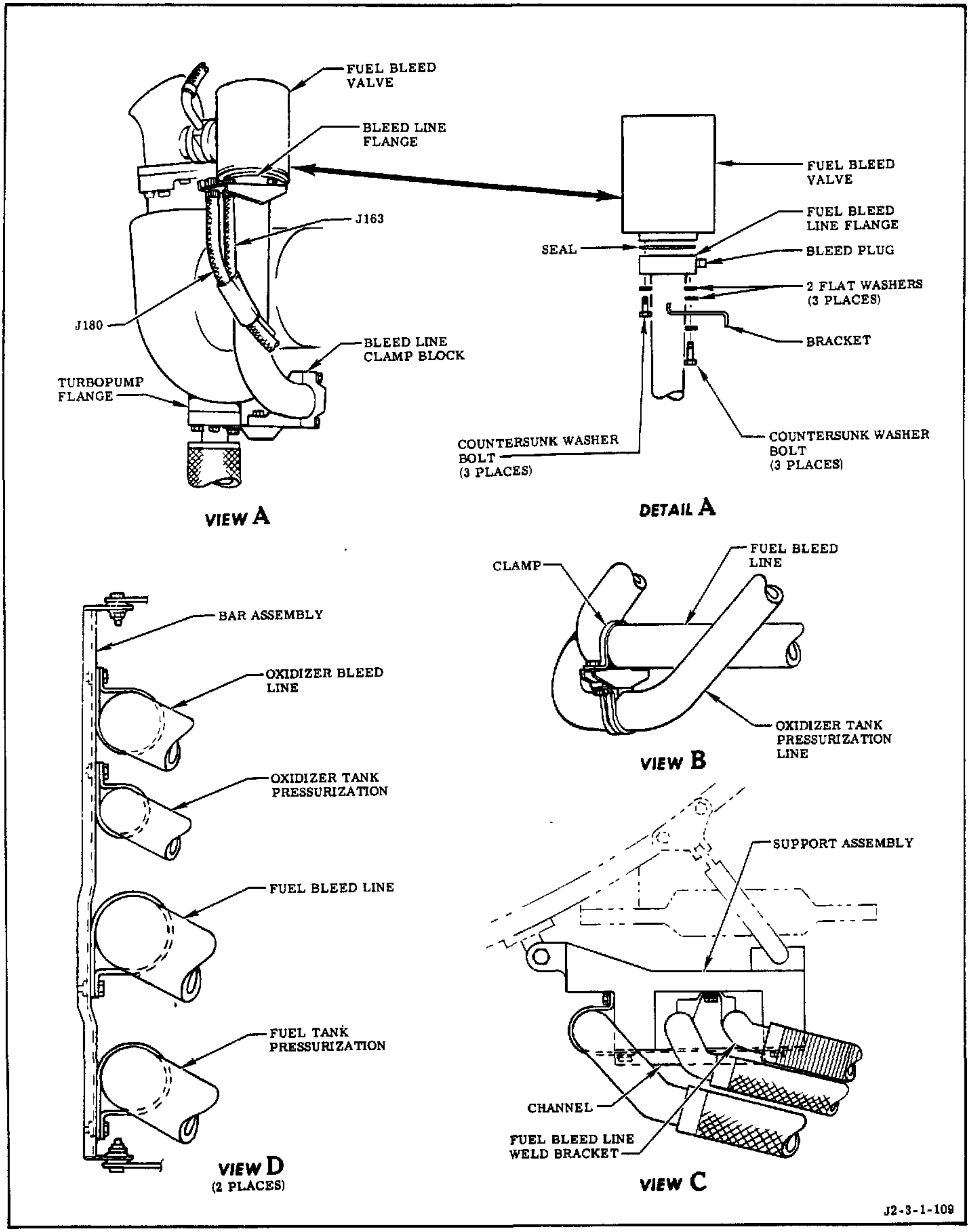


Figure 3-14. Fuel Bleed Line

i. Install clamp screws, washers, and nuts at the 2 bar assemblies on oxidizer bleed, oxidizer tank pressurization, fuel bleed, and fuel tank pressurization lines. (See figure 3-14, view D.) Torque screws to 24-30 in-lb.

j. Torque nuts on bolts that support the 2 bar assemblies until linkage locks and will not move; then back off nuts 1/2 turn and check for freedom of movement. Linkage must not bind.

k. If fuel bleed line was replaced, remove protective material from leak-test port in flange and from 1/4-inch-OD tube nut. Install gasket and bleed plug in flange leak-test port and torque plug to 22-28 in-lb. Install plug in 1/4-inch-OD tube nut, hold plug with box or end wrench, and torque tube nut to 110-130 in-lb.

l. On engines incorporating MD358 change, install insulation (paragraph 3-47C).

m. Refer to section IV for test requirements.

3-47A. FUEL BLEED LINE AND MOUNTING BRACKET INSULATION.

3-47B. REMOVING FUEL BLEED LINE AND MOUNTING BRACKET INSULATION.

a. Using a knife, cut and remove insulation from bleed line and mounting bracket. Care must be exercised to prevent nicking or scratching bleed line or other adjacent lines.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

b. Remove adhesive sealant from metal surfaces with a clean cloth dampened with cleaning compound (MIL-C-81302).

3-47C. INSTALLING FUEL BLEED LINE AND MOUNTING BRACKET INSULATION. These procedures apply a one inch (prior to compressing) thickness of Micro-Fiber felt to the fuel bleed line and mounting bracket. The Micro-Fiber felt is held in place with tying tape and covered with self-bonding silicone tape. (See figure 3-14A.) Special tools (needle and guide) to route tape behind the mounting bracket and fuel bleed line are required. Fabrication of these tools is shown in figure 3-14B.

a. Obtain the following:

(1) Micro-Fiber felt, Type E or Type 475 (Johns-Manville Products) 1/2 x 36 ±1/2 x 36 ±1/2 inches, 4 ±1 lb/cu ft

(2) P2650 silicone rubber tape (Johnson and Johnson, Inc), 0.010 x 2.00 x 972 inches and 0.010 x 1.00 x 972 inches

(3) Silicone reinforcing tape SA01020 (Moxness Products, Inc)

(4) Tying tape RB0150-026, Type III (Rocketdyne)

(5) White sealant RTV-102 (General Electric)

(6) One box of tongue depressors

(7) Sufficient amount of fiberglass 403-108 (Du Pont), or equivalent to fabricate guides to aid tape installation

(8) Cleaning compound (MIL-C-81302)

b. Fill gaps and surface irregularities with small pieces of Micro-Fiber felt and secure in place with tying tape RB0150-026 (Rocketdyne).

c. Install one layer of Micro-Fiber felt, Type E or Type 475 (Johns-Manville Products) to sufficiently cover mounting bracket and fuel bleed line. Overlapping of Micro-Fiber felt may be necessary to completely cover area. Secure in place with tying tape RB0150-026 (Rocketdyne).

d. Repeat step c until entire one inch (prior to compressing) of Micro-Fiber felt has been installed.

e. Carefully apply a minimum of 2 layers of P2650 silicone rubber tape (Johnson and Johnson, Inc) over Micro-Fiber felt by overlapping P2650 tape to center of adjacent strip of P2650 tape. Use fiberglass guide where necessary. (See figure 3-14A, step 1.)

f. Apply silicone reinforcing tape SA01020 (Moxness Products, Inc) vertically approximately 0.25 inch apart, and then apply silicone reinforcing tape SA01020 horizontally approximately 0.25 inch apart. (See figure 3-14A, steps 2 and 3.)

g. Apply P2650 tape to entire installation to provide a neat exterior cover. (See figure 3-14A, step 4.)

WARNING

The following specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

h. Seal P2650 tape to adjacent surfaces by bonding with white sealant RTV-102 (General Electric) as follows:

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

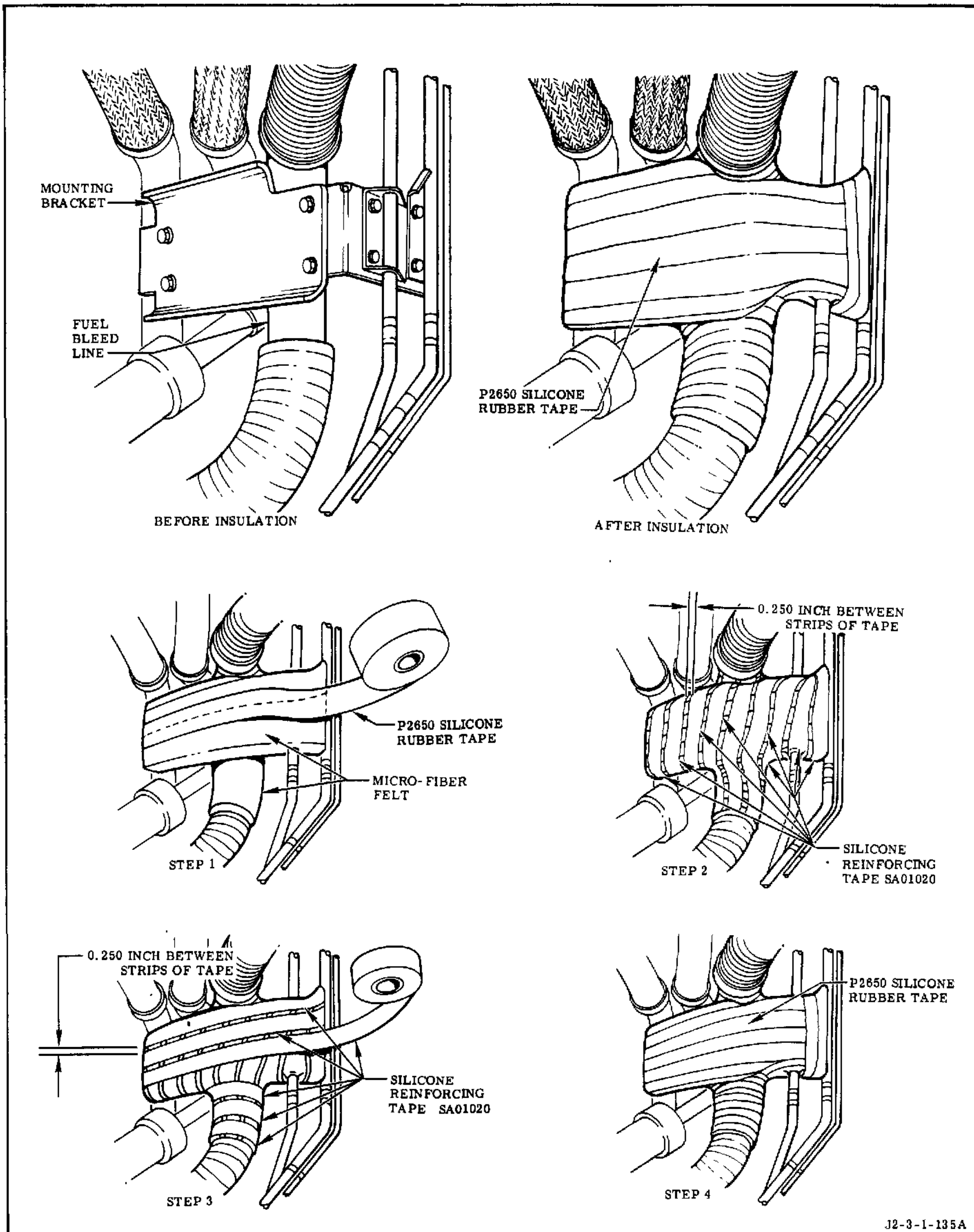


Figure 3-14A. Fuel Bleed Line and Mounting Bracket Insulation

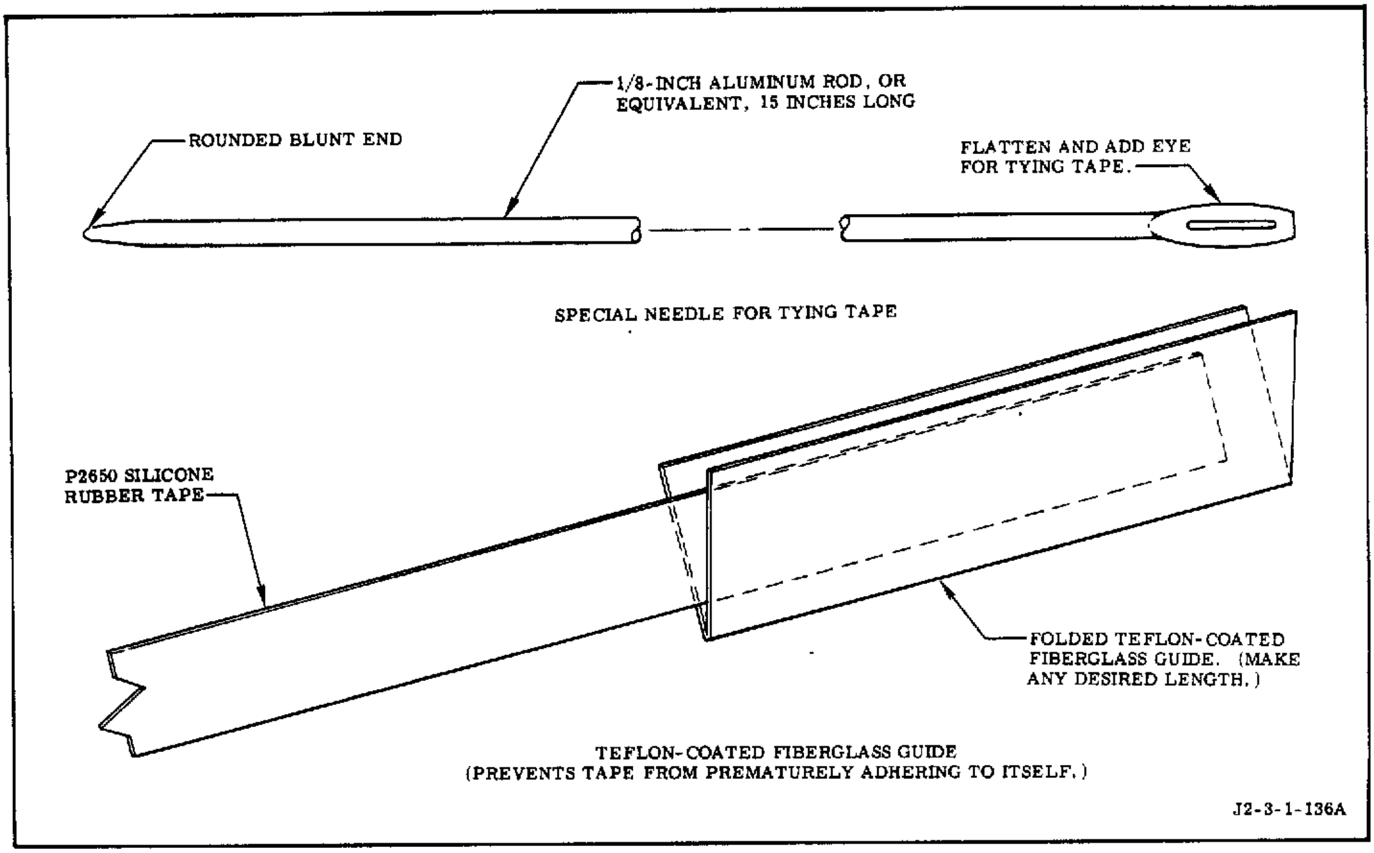


Figure 3-14B. Special Tools for Installing Fuel Bleed Line and Mounting Bracket Insulation

(1) Clean metal surface and adjacent existing insulation with a clean cloth dampened with cleaning compound (MIL-C-81302).

(2) Apply a bead of white sealant RTV-102 to previously cleaned surface and allow to cure until tack-free (approximately 5 minutes). Apply one layer of P2650 tape over sealant as tightly as possible without overstretching tape, to provide a bonding surface for subsequent sealing operation.

(3) Apply sealant RTV-102 to edges of completed insulation envelope. Use sealant to fill small gaps and voids where necessary. Care must be used to prevent excessive application of sealant.

3-48. FUEL BLEED VALVE TEMPERATURE TRANSDUCER.

3-49. REMOVING FUEL BLEED VALVE TEMPERATURE TRANSDUCER. (See figure 3-15.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (paragraph 3-30) P158 (8).

c. Remove bolts (7), washers (6), brackets (4, 5), lug (3), transducer (2), and seal (1).

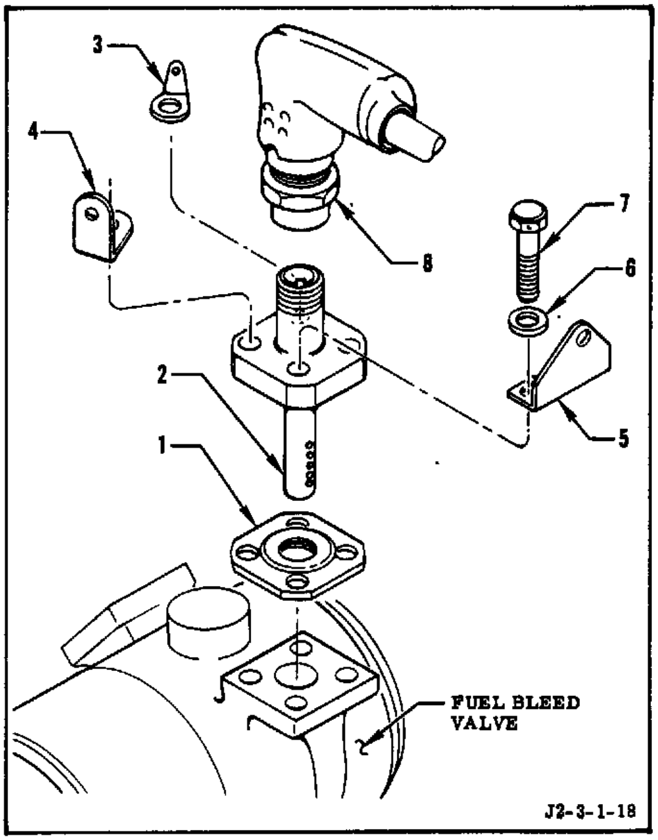
d. Install clean protective closures (paragraph 3-258).

3-50. INSTALLING FUEL BLEED VALVE TEMPERATURE TRANSDUCER. (See figure 3-15.)

a. If transducer is being replaced, verify that temperature transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from transducer and mating port on fuel bleed valve. Make sure transducer, engine



Index Number	Description
1	Seal
2	Temperature transducer
3	Lug
4	Bracket 502833-13
5	Bracket 502835
6	Washer
7	Bolt
8	Electrical connector P158

Figure 3-15. Fuel Bleed Valve Temperature Transducer

mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

c. Install seal (1) and transducer (2). Position transducer so that cable is not bent sharply or strained when key in transducer is alined with keyway in connector P158 (8). Figure 3-15 indicates desired position of transducer key provided connector cable is not bent sharply or strained.

d. Install lug (3) and brackets (4, 5) on transducer (2) and secure with washers (6) and bolts (7). Torque bolts (7) to 48-53 in-lb and safetywire.

e. Connect electrical connector (paragraph 3-31) P158 (8) to transducer (2).

f. Refer to section IV for test requirements.

3-51. FUEL HIGH-PRESSURE DUCT.

3-52. REMOVING FUEL HIGH-PRESSURE DUCT (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-16.)

a. If engine is in engine handler, obtain the following:

(1) Fuel feed system handler 9016787

(2) Component handler universal lifting sling 9016779

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove bolts and washers that secure GG fuel line to fuel high-pressure duct; remove seal, and protect open ports and sealing surfaces.

d. Remove vent port check valve (paragraph 3-308) from fast-shutdown valve; remove seal, and protect open ports and sealing surfaces.

e. Cut fuel turbopump discharge pressure line (PF3), and protect open line ends. (Refer to section VI for tube cutting requirements.)

eA. On engines incorporating MD88 or MD111 change, support pressure transducers (PF2, PF5, GO5, and GF4) and remove clamps, bolts, and washers that secure transducers to high-pressure fuel duct.

f. Disconnect electrical connectors (paragraph 3-30) P110 and P124.

fA. If fuel duct and flowmeter is to be replaced, proceed as follows:

(1) Remove fuel turbopump discharge temperature transducer (PFT1). (Refer to paragraph 3-88.)

(2) Remove plug and gasket at pressure transducer (PFT1) leak-test port. (See figure 3-23.)

g. Remove all but 2 equally spaced bolts from flanges that connect duct to turbopump and MFV.

h. If engine is in handler, install fuel feed system handler on fuel duct. Handler attaches to the 2 outboard tie rods. (See figure 3-16.) Attach universal lifting sling to fuel feed system handler.

i. If engine is in handler, attach overhead hoist to universal lifting sling and support weight of fuel duct (74 pounds) with overhead hoist. If engine is in unstacked stage, provide a suitable means of supporting fuel duct.

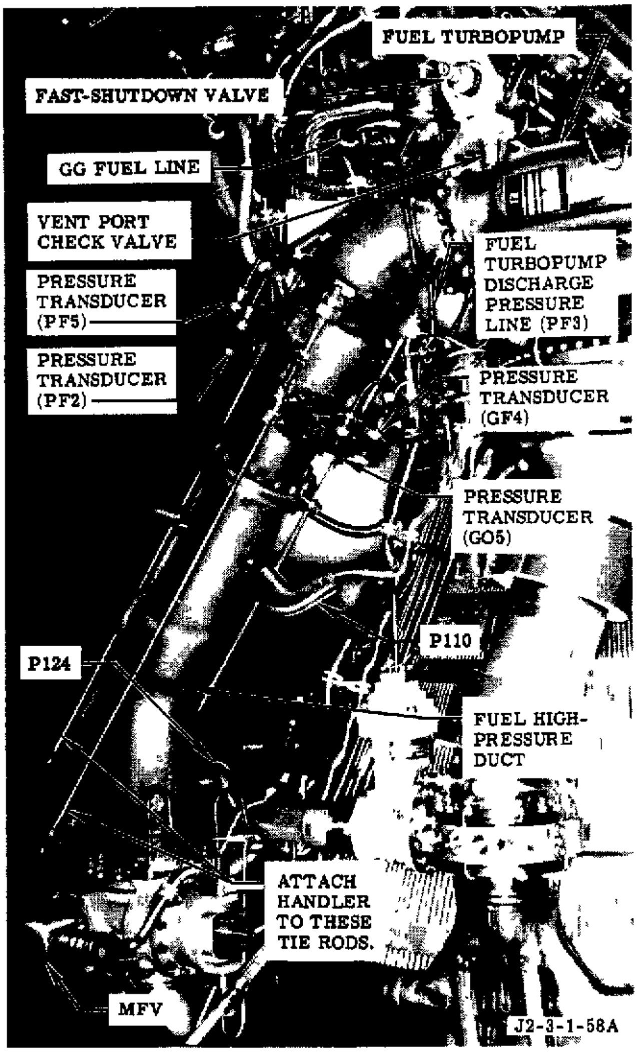


Figure 3-16. Fuel High-Pressure Duct

j. Remove remaining bolts and washers that secure high-pressure duct to MFV; remove seal, and protect open ports and sealing surfaces.

k. Remove remaining bolts and washers that secure high-pressure duct to fuel turbopump; remove seal and spacers, and protect open ports and sealing surfaces.

l. Move duct clear of engine.

m. Remove all protective material from fuel high-pressure duct and engine ports; install clean protective closures (paragraph 3-258).

3-53. REMOVING FUEL HIGH-PRESSURE DUCT (STACKED SII STAGE). (See figure 3-16.)

a. Obtain the following: (Items 3 through 6 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Fuel feed system handler 9016787-11

(2) Component handling angle adapter 9027172 from Engine Components Installer G4071

(3) Component handler universal lifting sling 9016779

(4) Chain-hoist 9027095 from engine components installer set 9026251

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Component handling cart 9026253-11 from engine components installer set 9026251

(8) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. Assemble track (section V) around engine from which fuel high-pressure duct is to be removed. Install turntable with controls leading for engine positions 1 through 4, and trailing for engine position 5. Position hoist at track station 9 for engine positions 1 through 4, or track station 23 for engine position 5.

c. Install angle adapter on boom as shown in figure 3-6, view E.

d. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

e. Remove bolts and washers that secure GG fuel line to fuel high-pressure duct; remove seal, and protect open ports and sealing surfaces.

f. Remove vent port check valve (paragraph 3-308) from fast-shutdown valve; remove seal, and protect open ports and sealing surfaces.

g. Cut fuel turbopump discharge pressure line (PF3), and protect open line ends. (Refer to section VI for tube cutting requirements.)

h. Disconnect electrical connectors (paragraph 3-30) P110 and P124.

hA. If fuel duct and flowmeter is to be replaced, proceed as follows:

(1) Remove fuel turbopump discharge temperature transducer (PFT1). (Refer to paragraph 3-88.)

(2) Remove plug and gasket at pressure transducer (PFT1) leak-test port. (See figure 3-23.)

i. Remove all but 2 equally spaced bolts from flanges that connect duct to turbopump and MFV.

j. Remove any remaining stage-installed equipment or instrumentation lines attached to or interfering with duct removal, using applicable stage procedures.

k. Install fuel feed system handler on fuel duct. Handler attaches to the 2 outboard tie rods. (See figure 3-16.)

l. Attach boom to handler and secure with ball-lock pin.

m. Support weight of fuel high-pressure duct (74 pounds) with hoist.

n. Remove remaining bolts and washers that secure high-pressure duct to MFV; remove seal, and protect open ports and sealing surfaces.

o. Remove remaining bolts and washers that secure high-pressure duct to fuel turbopump; remove seal and spacers, and protect open ports and sealing surfaces.

p. Move duct clear of engine.

q. Remove all protective material from fuel high-pressure duct and engine ports; install clean protective closures (paragraph 3-258).

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps r through u.

r. Using hoist, move duct to an accessible area near stage access door and place duct on protective pad.

s. Install component handler universal lifting sling on handler and secure with ball-lock pin.

t. Remove adapter and install chain-hoist on hoist.

u. Connect chain-hoist hook to component handler universal lifting sling, and raise fuel high-pressure duct with chain-hoist.

v. Transport fuel high-pressure duct through stage access door, and lower duct into component handling cart. Disengage component from hoist, manually lifting component, if necessary, to disengage.

3-54. REMOVING FUEL HIGH-PRESSURE DUCT (STACKED SIVB STAGE). (See figure 3-16.)

a. Obtain the following:

(1) Fuel feed system handler 9016787-11

(2) Extension 9027080 from Engine Components Installer G4072

(3) Sleeve 9027084 from Engine Components Installer G4072

(4) Component handling cart 9026253-11 from engine component installer set 9026252

(5) Ramp 9026255 (2 required) and 9026255-11 from engine component installer set 9026252 (required for use on launch tower umbilical arm)

b. Assemble track for fuel high-pressure duct removal. (Refer to section V.) Install turntable with controls leading.

c. Install sleeve, extension, and handler on hoist. (See figure 3-6, view G.) Position extension in 8th positioning hole (500-series stage) or 9th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pins.

d. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

e. Remove bolts and washers that secure GG fuel line to fuel high-pressure duct; remove seal, and protect open ports and sealing surfaces.

f. Remove vent port check valve (paragraph 3-308) from fast-shutdown valve; remove seal, and protect open ports and sealing surfaces.

g. Cut fuel turbopump discharge pressure line (PF3), and protect open line ends. (Refer to section VI for tube cutting requirements.)

h. Disconnect electrical connector (paragraph 3-30) P110 and P124.

hA. If fuel duct and flowmeter is to be replaced, proceed as follows:

(1) Remove fuel turbopump discharge temperature transducer (PFT1). (Refer to paragraph 3-88.)

(2) Remove plug and gasket at pressure transducer (PFT1) leak-test port. (See figure 3-23.)

i. Remove all but 2 equally spaced bolts from flanges that connect duct to turbopump and MFV.

j. Remove any remaining stage-installed equipment or instrumentation lines attached to or interfering with duct removal, using applicable stage procedures.

k. Manipulate hoist to lower handler through opening in which access work platform is installed, and orient handler with fuel high-pressure duct.

l. Install handler on fuel duct. Handler attaches to the 2 outboard tie rods. (See figure 3-16.)

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

m. Support weight of fuel high-pressure duct (74 pounds) by manipulation of hoist and turnbuckle on extension. Make sure a minimum of one thread is evident in turnbuckle barrel when turnbuckle is extended.

n. Remove remaining bolts and washers that secure high-pressure duct to MFV; remove seal, and protect open ports and sealing surfaces.

o. Remove remaining bolts and washers that secure high-pressure duct to fuel turbopump; remove seal and spacers, and protect open ports and sealing surfaces.

p. Move duct clear of engine.

NOTE

Because of the remoteness of the hoist operator and deflection of the hoisting equipment, it is recommended that a technician guide the duct and otherwise assist the hoist operator.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

q. Using hoist and extension turnbuckle, move fuel high-pressure duct through opening in which access work platform is installed. Make sure a minimum of one thread is evident in turnbuckle barrel when turnbuckle is extended.

r. Using hoist, move fuel high-pressure duct to an accessible area near stage access door.

s. Remove all protective material from fuel high-pressure duct and engine ports; install clean protective closures (paragraph 3-258).

t. Remove fuel high-pressure duct from handler, and temporarily place duct on protective pad.

u. Manually carry fuel high-pressure duct through stage access door and place in component handling cart. A suggested method of handling the duct is to attach slings 6001-5-3 at each end of fuel high-pressure duct. Install slings around duct inside of tie rods, using a choker hitch.

3-55. INSTALLING FUEL HIGH-PRESSURE DUCT (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-16.)

a. If engine is in engine handler, obtain the following:

(1) Fuel feed system handler 9016787-11

(2) Component handler universal lifting sling 9016779

b. If fuel high-pressure duct is to be installed on an engine in engine handler, install fuel feed system handler on fuel duct. Handler attaches to 2 tie rods. (See figure 3-16.) Attach universal lifting sling to fuel feed system handler.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove protective closures (paragraph 3-257). Make sure fuel high-pressure duct, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

e. If fuel high-pressure duct is to be installed on engine in handler, attach overhead hoist to universal lifting sling and, using overhead hoist, position duct on engine. If duct is to be installed on engine in unstacked stage, provide suitable means of handling fuel high-pressure duct. The fuel high-pressure duct weighs 74 pounds.

f. Remove protective material from mating flanges of MFV to fuel duct; install seal, attaching bolts, and washers. Cross-torque bolts to 605-669 in-lb and safetywire.

g. Check for misalinement of duct and turbopump flanges. Should misalinement exist, the duct may be extended a maximum of 0.5 inch or compressed a maximum of 0.75 inch to effect alinement. Duct can be extended during installation of flange bolts. Make sure tie rods are loosened sufficiently to permit duct extension. Compress duct by shortening tie rods.

h. Remove protective material from mating flanges of fuel duct to turbopump, install seal and spacers, and secure flanges and fast-shutdown valve with bolts and washers. If necessary, loosen tie rods if preloading is evident. Cross-torque bolts to 361-399 in-lb and safetywire.

i. Remove handler and sling from duct.

j. Adjust the 3 tie rods so that with nut at one end of rod snug, a 0.025-inch feeler gage is a snug fit at opposite end.

k. Preload duct by holding tie rod nut on one end and tightening nut on opposite end exactly 3 revolutions. Perform this operation on all tie rods.

l. Safetywire tie-rod nuts to tie rods.

m. Remove protective material from GG fuel line and mating flange on fuel duct; install seal, and secure fuel line to duct with bolts and washers. Cross-torque bolts to 143-157 in-lb and safetywire.

n. Install vent port check valve (paragraph 3-309).

o. Check torque of fuel turbopump discharge pressure line (PF3) adapter. Torque must be 67-73 in-lb. If torque is low, remove adapter, replace seal, reinstall adapter, and torque adapter to 67-73 in-lb.

p. Remove protective material and weld (section VI) fuel turbopump discharge pressure line (PF3).

pA. On engines incorporating MD88 or MD111 change, reinstall pressure transducers (PF2, PF5, GO5, and GF4) using clamps, bolts, and washers to secure transducers to high-pressure fuel duct.

pB. If fuel duct and flowmeter were replaced, proceed as follows:

(1) Install fuel turbopump discharge temperature transducer (PFT1). (Refer to paragraph 3-89.)

(2) Install plug and gasket at pressure transducer (PFT1) leak-test port. Torque plug to 22-28 in-lb and safetywire. (See figure 3-23.)

q. Connect electrical connectors (paragraph 3-31) P110 and P124.

r. Refer to section IV for test requirements.

3-56. INSTALLING FUEL HIGH-PRESSURE DUCT (STACKED SII STAGE). (See figure 3-16.)

a. Obtain the following: (Items 2 through 5 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Fuel feed system handler 9016787-11

(2) Component handler universal lifting sling 9016779

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Component handling cart 9026253-11 from engine components installer set 9026251

(7) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. Using component handling cart, transport fuel high-pressure duct to stage.

c. Attach handler to fuel duct. (See figure 3-16 for identification of rods to which handler is attached.)

NOTE

If the launch tower umbilical arm is to be used for transporting the component to the stage, omit steps d through i.

d. Attach component handler universal lifting sling to duct handler.

e. Attach chain-hoist to hoist.

f. Using universal joint, extension bar, and a suitable tool to operate chain-hoist, manipulate hoist and chain-hoist so that hook of chain-hoist attaches to lifting sling on duct handler.

g. Raise duct with chain-hoist and hoist and move duct into stage.

h. Lower duct onto a protective pad, and disengage chain-hoist hook. To prevent the need to manually lift duct when reattaching duct to hoist, lay duct on a platform so that hoist adapter is positioned on fuel feed system handler not more than 2.5 inches below centerline of track.

i. Retract chain fully into chain hoist, and remove chain hoist from hoist.

j. Install angle adapter on hoist in position shown in figure 3-6, view E, and secure with ball-lock pin.

k. Attach hoist to fuel feed system handler, manually lifting duct, if necessary, to effect connection.

l. Move hoist to track station 23 if duct is being installed on engine in engine positions 1 through 4, or track station 9 if duct is being installed on engine in engine position 5.

m. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

n. Remove protective closures (paragraph 3-257). Make sure fuel high-pressure duct, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

o. Position duct on engine.

p. Remove protective material from mating flanges of MFV to fuel duct; install seal attaching bolt, and washers. Cross-torque bolts to 605-669 in-lb and safetywire.

q. Check for misalinement of duct and turbopump flanges. Should misalinement exist, the duct may be extended a maximum of 0.5 inch or compressed a maximum of 0.75 inch to effect alinement. Duct can be extended during installation by tightening flange bolts. Make sure tie rods are loosened sufficiently to permit duct extension. Compress duct by shortening tie rods.

r. Remove protective material from mating flanges of fuel duct to turbopump, install seal and spacers, and secure flanges and fast-shutdown valve with bolts and washers. If necessary, loosen tie rods if preloading is evident. Cross-torque bolts to 361-399 in-lb and safetywire.

s. Disconnect handler from duct and move handler clear of engine.

t. Disassemble track. (Refer to section V.)

u. Adjust the 3 tie rods so that with nut at one end of rod snug, a 0.025-inch feeler gage is a snug fit at opposite end.

v. Preload duct by holding tie rod nut on one end and tightening nut on opposite end exactly 3 revolutions. Perform this operation on all tie rods.

w. Safetywire tie-rod nuts to tie rods.

x. Remove protective material from GG fuel line and mating flange on fuel duct; install seal and secure fuel feed line to discharge duct with bolts and washers. Cross-torque bolts to 143-157 in-lb and safetywire.

y. Install vent port check valve (paragraph 3-309).

z. Check torque of fuel turbopump discharge pressure line (PF3) adapter. Torque must be 67-73 in-lb. If torque is low, remove adapter, replace seal, reinstall adapter, and torque adapter to 67-73 in-lb.

aa. Remove protective material and weld (section VI) fuel turbopump discharge pressure line (PF3).

aaA. If fuel duct and flowmeter were replaced, proceed as follows:

(1) Install fuel turbopump discharge temperature transducer (PFT1). (Refer to paragraph 3-89.)

(2) Install plug and gasket in pressure transducer (PFT1) leak-test port. Torque plug to 22-28 in-lb and safetywire. (See figure 3-23.)

ab. Connect electrical connectors (paragraph 3-31) P110 and P124.

ac. Refer to section IV for test requirements.

3-57. INSTALLING FUEL HIGH-PRESSURE DUCT (STACKED SIVB STAGE). (See figure 3-16.)

a. Obtain the following:

(1) Fuel feed system handler 9016787-11

(2) Extension 9027080 from Engine Components Installer G4072

(3) Sleeve 9027084 (200-series vehicle) or 9027084-11 (500-series vehicle) from Engine Components Installer G4072

(4) Component handling cart 9026253-11 from engine components installer set 9026252

(5) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026252 (required for use on launch tower umbilical arm)

b. Using component handling cart, transport fuel high-pressure duct to stage.

c. Transfer duct (74 pounds) into stage and place on protective pad. A suggested method of handling the duct is to attach a sling 6001-5-3 at each end of duct with sling installed between tie rods around duct, using a choker hitch.

d. Install sleeve and extension on hoist. (See figure 3-6, view G.) Position extension in 8th positioning hole (500-series stage) or in 9th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

e. Attach handler to hoist extension with web strap uppermost. Secure with ball-lock pin.

f. Attach handler to fuel duct. (See figure 3-16 for identification of rods to which handler is attached.)

g. Using hoist, move fuel high-pressure duct to engine position. Suspend duct over track so that duct is opposite turntable controls.

h. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

i. Remove protective closures (paragraph 3-257). Make sure fuel high-pressure duct, engine mating connections, threads in parent metal, and/or threaded inserts are clean and

free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

j. Lower fuel high-pressure duct through opening in which lower platform is installed. Make sure a minimum of one thread is evident in turnbuckle barrel when turnbuckle is extended.

NOTE

Because of the remoteness of the hoist operator from the fuel high-pressure duct installation area and deflection of hoisting equipment, it is recommended that a technician guide the duct and otherwise assist the hoist operator.

k. Position duct on engine.

l. Remove protective material from mating flanges of MFV to fuel duct; install seal and attaching bolts and washers. Cross-torque bolts to 637 ±32 in-lb and safetywire.

m. Check for misalinement of fuel duct and turbopump flanges. Should misalinement exist, the duct may be extended a maximum of 0.5 inch or compressed a maximum of 0.75 inch to effect alinement. Duct can be extended during installation by tightening flange bolts. Make sure tie rods are loose enough to permit duct extension. Compress duct by shortening tie rods.

n. Remove protective material from mating flanges of fuel duct to turbopump, install seal and spacers, and,secure flanges and fast-shutdown valve with bolts and washers. If necessary, loosen tie rods if preloading is evident. Cross-torque bolts to 380 ±19 in-lb and safetywire.

o. Disconnect handler from duct, and move handler clear of engine.

p. Disassemble track. (Refer to section V.)

q. Adjust the 3 tie rods so that with nut at one end of rod snug, a 0.025-inch feeler gage is a snug fit at opposite end.

r. Preload duct by holding tie rod nut on one end and tightening nut on opposite end exactly 3 revolutions. Perform this operation on all tie rods.

s. Safetywire tie-rod nuts to tie rods.

t. Remove protective material from GG fuel line and mating flange on fuel duct; install seal and secure fuel feed line to discharge duct with bolts and washers. Cross-torque bolts to 150 ±7 in-lb and safetywire.

u. Install vent port check valve (paragraph 3-309).

v. Torque fuel turbopump discharge pressure line (PF3) adapter to 67 in-lb. If adapter tube stub alines with existing line, proceed to next step. If adapter tube stub does not aline with existing line, remove and replace adapter and seal, and torque adapter to 70 ±3 in-lb.

w. Remove protective material and weld (section VI) fuel turbopump discharge pressure line (PF3).

wA. If fuel duct and flowmeter were replaced, proceed as follows:

(1) Install fuel turbopump discharge temperature transducer (PFT1). (Refer to paragraph 3-89.)

(2) Install plug and gasket in pressure transducer (PFT1) leak-test port. (Torque plug to 25 ±3 in-lb and safetywire. (See figure 3-23.)

x. Connect electrical connectors (paragraph 3-31) P110 and P124.

y. Refer to section IV for test requirements.

3-58. FUEL INLET DUCT.

3-59. REMOVING FUEL INLET DUCT (ENGINE HANDLER). (See figure 3-17.)

a. Obtain the following:

(1) Propellant inlet duct sling 9024400.

(2) Torque wrench adapter T-5040045.

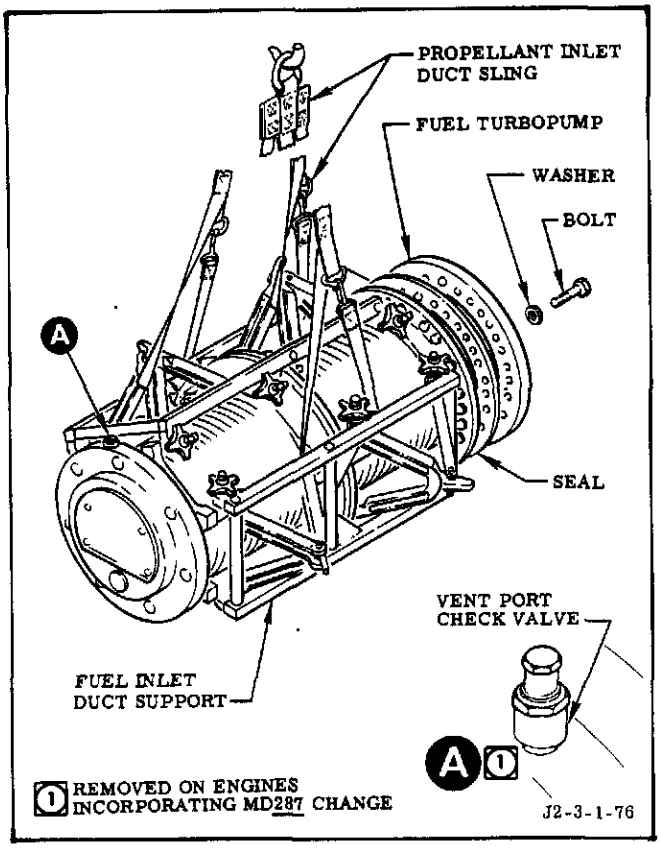


Figure 3-17. Fuel Inlet Duct

(3) Fuel pump inlet flange adapter RK395-44094-011.

(4) Pump inlet closure RX-20714.

(5) Plate RK395-10044.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure torsional ring protective covers are installed on inlet duct.

d. Make sure fuel inlet duct supports (minimum of 2) are installed on inlet duct.

CAUTION

The fuel inlet duct supports must be in place when using the inlet duct sling, to prevent damage to the fuel inlet duct.

e. Install propellant inlet duct sling on fuel inlet duct by looping 3 straps through inlet duct bipods and connecting snap fasteners.

CAUTION

The use of excessive lifting force of the hoist on the installed inlet duct can damage the engine.

f. Connect lifting eye of inlet duct sling to a hoist and raise hoist until sling supports inlet duct.

g. Remove bolts and washers that secure fuel inlet duct to turbopump inlet flange, using torque wrench adapter only when necessary. Notice location of, and support, fuel interstage pressure transducer and support and fuel pump accelerometer mount. On engines incorporating MD233 change, the transducer and support have been removed.

CAUTION

The turbopump inducer extends into the duct 4 inches and can be damaged if struck by the fuel inlet duct.

NOTE

The weight of the fuel inlet duct (exclusive of turnbuckles) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

h. Remove inlet duct from turbopump inlet flange, taking care not to bump or otherwise damage sealing surfaces:

i. Remove seal from turbopump inlet flange.

j. Make sure turbopump inlet and flange are clean and free of damage.

k. Install fuel pump inlet flange adapter on fuel turbopump inlet using 6 bolts and washers. Torque bolts to 25-30 in-lb.

l. Install pump inlet closure (paragraph 3-258) on adapter using 8 screws and washers.

m. Install plate (paragraph 3-258) on lower (downstream) flange of inlet duct using 12 screws and washers.

n. Make sure inlet duct covers and inlet duct pads are installed.

o. Make sure inlet ducts closure and plate are correctly installed on upper (upstream) flange of inlet duct.

3-60. REMOVING FUEL INLET DUCT (UNSTACKED STAGE). (See figure 3-17.) The fuel inlet duct may be removed, reinstalled, or replaced on SII-stage engine positions 1 through 4 and on the SIVB-stage engine. Removal of the fuel inlet duct from engine position 5 (SII stage) must be done in accordance with applicable Stage Contractor procedures.

a. Obtain the following:

(1) Torque wrench adapter T-5040045.

(2) Inlet duct support frame installing tool kit 9025150.

(3) Split barrel EWR 915725.

(4) Plate EWR 915726.

(5) Teflon sheet EWR 915729.

(6) Fuel duct plate EWR 972057.

(7) Plate RK395-52111.

(8) Aclar No. 33C film (Allied Chemical Corp).

(9) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(10) Fuel-pump inlet flange adapter RK395-44094-011.

(11) Pump inlet closure RX-20714.

(12) Inlet ducts closure RK395-10124 or -011.

(13) Plate RK395-10044.

(14) Fuel inlet duct supports RK395-44101, -011, -021, and/or -031.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure torsional ring protective covers are installed on inlet duct.

d. Remove bolts and washers that secure fuel inlet duct to turbopump inlet flange, using torque wrench adapter only when necessary. Notice location of brackets and mounts for reinstallation.

e. Support fuel interstage pressure transducer and support and fuel pump accelerometer mount. On engines incorporating MD233 change, the transducer and support have been removed.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

f. Install 3 turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150 on fuel inlet duct bipods.

g. Compress duct by tightening the 3 turnbuckles evenly, in small increments, until duct has been compressed enough to remove seal from turbopump inlet flange. Do not compress duct to less than 18.85 inches.

h. Remove seal from turbopump inlet flange.

i. Make sure turbopump inlet and flange are clean and free of damage.

iA. If additional clearance is required to install plates in steps j through m, manually gimbal engine 2-3 degrees in appropriate direction.

j. Install 2 halves of split barrel EWR 915725 on turbopump inlet flange using bolts.

k. Install plate EWR 915726 on split barrel using bolts.

l. Place Teflon sheet EWR 915729 on plate.

m. Install and secure duct plate EWR 972057 on lower flange of inlet duct, using holding springs or other provided fasteners.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

n. Loosen 3 turnbuckles evenly, in small increments, so that plate on fuel inlet duct flange contacts Teflon sheet on turbopump inlet flange.

o. Using Stage Contractor procedures, remove bolts that secure fuel inlet duct to customer connect flange.

oA. On SII stages, disconnect one or both interface duct flange support struts from flange clevises; then remove clevises from flange.

oB. Using an appropriate block and tackle or pulley arrangement, support inlet duct to appropriate stage structure to prevent dropping duct and to assist lowering of duct.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

p. Support the inlet duct and compress duct by tightening the 3 turnbuckles evenly, in small increments, until seal at customer connect flange can be removed. Do not compress duct to less than 18.85 inches.

q. Remove seal from customer connect flange.

r. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange and customer connect flange. Fasten in place with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads on sealing surfaces.

NOTE

On SIVB stages, the engine must be manually gimbaled to provide enough clearance to remove the fuel inlet duct. To gimbal the engine, the stage hydraulic bypass system must be used to unlock hydraulic pressure.

s. On SIVB stages, using stage procedures, manually gimbal engine 2-3 degrees in appropriate direction to allow fuel inlet duct removal.

CAUTION

In the following step the duct may be compressed more to aid in removal, but the duct must not be compressed to less than 18.85 inches since damage can result.

t. Remove fuel inlet duct by slowly sliding duct on Teflon sheet until duct clears turbopump and customer connect flanges, taking care not to bump or otherwise damage sealing surfaces. With duct removed, return engine to neutral gimbal position.

u. Remove Teflon sheet, plate, and split barrel from turbopump inlet flange.

v. Make sure turbopump inlet and flange are clean and free of damage.

w. Install fuel pump inlet flange adapter on fuel turbopump inlet using 6 bolts and washers. Torque bolts to 25-30 in-lb.

x. Install pump inlet closure (paragraph 3-258) on adapter using 8 screws and washers.

y. Remove fuel duct plate EWR 972057 from lower flange of inlet duct and install plate RK395-52111 (paragraph 3-258) using 12 screws and washers.

z. Remove Aclar film and tape from customer connect flange and install protective closure as specified in Stage Contractor procedures.

aa. Remove Aclar film and tape from upper flange of fuel inlet duct and install plate and inlet ducts closure (paragraph 3-258) using 12 screws and washers.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

ab. Using turnbuckles to adjust length of fuel inlet duct, install fuel inlet duct supports (minimum of 2) on inlet duct with hand knobs to left side of bipods when duct is viewed from inlet end.

ac. Remove turnbuckles from inlet duct bipods.

ad. Make sure inlet duct covers and inlet duct pads are installed.

3-61. REMOVING FUEL INLET DUCT (STACKED SII STAGE). (See figure 3-17.) The fuel inlet duct may be removed and reinstalled

or replaced on stacked SII-stage engine positions 1 through 4. This procedure is for removing fuel inlet duct from engine positions 1 through 4 only. Removal of the fuel inlet duct from engine position 5 must be done in accordance with applicable Stage Contractor procedures. The procedure in paragraph 3-60, Removing Fuel Inlet Duct (Unstacked Stage), may be used if additional provisions are made to protect personnel from injury and equipment from damage in a stacked stage.

a. Obtain the following: (Items 12, 18, 21, and 22 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Engine Components Installer G4071.

(2) Component handler adapter 9027174 from Engine Components Installer G4071, shelf 2.

(3) Engine components installer set 9026251.

(4) Torque wrench adapter T-5040045.

(5) Fuel inlet duct handler 9016784.

(6) Split barrel EWR 915725.

(7) Plate EWR 915726.

(8) Teflon sheet EWR 915729.

(9) Fuel duct plate EWR 972057.

(10) Aclar No. 33C film (Allied Chemical Corp).

(11) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(12) Chain hoist 9027095 from engine components installer set 9026251.

(13) Fuel pump inlet flange adapter RK395-44094-011.

(14) Pump inlet closure RX-20714.

(15) Plate RK395-52111.

(16) Inlet ducts closure RK395-10124 or -011.

(17) Plate RK395-10044.

(18) Component handler universal lifting sling 9016779.

(19) Inlet duct support frame installing tool kit 9025150.

(20) Fuel inlet duct supports RK395-44101, -011, -021, and/or -031.

(21) Universal joint S8 from engine components installer set 9026251.

(22) Extension bar SX-24 from engine components installer set 9026251.

(23) Component handling cart 9026253-11 from engine components installer set 9026251.

(24) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure torsional ring protective covers are installed on inlet duct.

d. Install track and hoist (section V) around engine positions (1 through 4) from which inlet duct is to be removed. Install turntable with controls trailing, and position hoist at track station 4.5.

e. Install handler adapter on hoist in position shown in figure 3-6, view F.

f. Remove bolts and washers that secure fuel inlet duct to turbopump inlet flange, using torque wrench adapter only when necessary. Notice location of brackets and mounts for reinstallation.

g. Support fuel interstage pressure transducer and support and fuel pump accelerometer mount. On engines incorporating MD233 change, the transducer and support have been removed.

h. Install fuel inlet duct handler with adapter socket positioned in direction of track station 7 as follows:

(1) Rotate knurled nuts (2 places) to retract supports.

(2) At end of handler marked TANK END, make sure pivoted lock is rotated and secured to prevent obstruction of handler opening.

(3) Place slide arm in extreme outward position and secure with ball-lock pin.

(4) With handler oriented with adapter socket toward ECA, place handler on duct, making sure notches in top and bottom end plates engage lugs at bipod attach fittings.

(5) Move slide arm into position and secure with ball-lock pin.

(6) Rotate and secure pivoted lock.

(7) Extend supports by rotating knurled nuts until positive engagement is made with duct.

i. Compress duct to maximum allowed by handler.

j. Remove seal from turbopump inlet flange.

k. Make sure turbopump inlet and flange are clean and free of damage.

l. Install split barrel EWR 915725 on turbopump inlet flange using bolts.

m. Install plate EWR 915726 on split barrel using bolts.

n. Install Teflon sheet on plate.

o. Install fuel duct plate EWR 972057 on fuel inlet duct flange. Secure plate to duct with pressure-sensitive tape RB0195-002 (Rocketdyne).

p. Attach hoist to fuel inlet duct handler and secure with ball-lock pin.

q. Using Stage Contractor procedures, remove bolts that secure fuel inlet duct to customer connect flange.

r. Lower duct until duct flange contacts Teflon sheet on turbopump inlet flange.

s. Remove seal at customer connect flange.

t. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange and customer connect flange. Fasten in place with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

NOTE

The weight of the fuel inlet duct (exclusive of handler) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

u. Operate hoist to raise and move fuel inlet duct clear of Teflon sheet on turbopump inlet flange and customer connect flange, taking care not to bump or otherwise damage sealing surfaces.

v. Remove Teflon sheet, plate, and split barrel from turbopump inlet flange.

w. Make sure turbopump inlet and flange are clean and free of damage.

x. Install fuel pump inlet flange adapter on fuel turbopump inlet using 6 bolts and washers. Torque bolts to 25-30 in-lb.

y. Install pump inlet closure (paragraph 3-258) on adapter using 8 screws and washers.

z. Remove Aclar film and tape from customer connect flange, and install protective closure as outlined by Stage Contractor procedures.

aa. Remove Aclar film and tape from upper flange of fuel inlet duct and install plate and inlet ducts closure (paragraph 3-258) using 12 screws and washers.

ab. Remove fuel duct plate EWR 972057 from lower flange of fuel inlet duct.

ac. Make sure inlet duct and sealing surface are clean and free of damage.

ad. Install plate RK395-52111 (paragraph 3-258) using 12 screws and washers.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps ae through ai; otherwise, omit step af.

ae. Using hoist, transfer duct through stage access door and lower into component handling cart.

af. Using hoist, transfer duct by stage access door and place on protective pad.

ag. Attach component handler universal lifting sling to handler on duct.

ah. Remove handler adapter from hoist boom and install chain-hoist.

ai. Attach hook of hoist to sling and raise duct.

aj. Move duct through stage access door and lower into component handling cart.

ak. If fuel inlet duct handler is to be removed, install inlet duct support as follows:

(1) Remove handler from fuel inlet duct.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

(2) Install 3 turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150 on inlet duct bipods.

(3) Using turnbuckles to adjust length of fuel inlet duct, install fuel inlet duct supports (minimum of 2) on inlet duct with handknobs to left side of bipods when duct is viewed from inlet end.

al. Extend and remove turnbuckles from inlet duct bipods.

am. Make sure inlet duct covers and inlet duct pads are installed.

3-62. REMOVING FUEL INLET DUCT (STACKED SIVB STAGE). The procedure in paragraph 3-60, Removing Fuel Inlet Duct (Unstacked Stage), may be used if additional provisions are made to protect personnel from injury and equipment from damage in a stacked stage.

a. Obtain the following:

(1) Component handling cart 9026253-11 from engine components installer set 9026252.

(2) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026252 (required for use on launch tower umbilical arm).

(3) Torque wrench adapter T-5040045.

(4) Inlet duct support frame installing tool kit 9025150.

(5) Aclar No. 33C film (Allied Chemical Corp).

(6) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(7) Split barrel EWR 915725.

(8) Plate EWR 915726.

(9) Teflon sheet EWR 915729.

(10) Fuel duct plate EWR 972057.

(11) Spacer, 2 ±1/8 inches thick. (Spacer is required to keep duct in a compressed attitude to permit installation of handler. Configuration of spacer must allow insertion at customer connect flange. Spacer may be made of any material that will not cause contamination or damage sealing surfaces, and can withstand duct compression forces of 480 lb/in. (maximum) of duct compression.)

(12) Fuel inlet duct handler 9016784.

(13) Fuel pump inlet flange adapter RK395-44094-011.

(14) Pump inlet closure RX-20714.

(15) Plate RK395-52111.

(16) Inlet ducts closure RK395-10124 or -011.

(17) Plate RK395-10044.

(18) Fuel inlet duct supports RK395-44101, -011, -021, and/or -031.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure torsional ring protective covers are installed on inlet duct.

d. Install track and hoist for fuel inlet duct removal, as required for applicable stage. (Refer to section V.) Install turntable with controls trailing.

e. Remove bolts and washers that secure fuel inlet duct to turbopump inlet flange, using torque wrench adapter only when necessary. Notice location of support and mount for reinstallation.

f. Support fuel interstage pressure transducer and support, and fuel pump accelerometer mount. On engines incorporating MD233 change, the transducer and support have been removed.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

g. Install 3 turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150 on fuel inlet duct bipods.

h. Compress duct by tightening the 3 turnbuckles evenly, in small increments, until duct has been compressed enough to remove seal from turbopump inlet flange. Do not compress duct to less than 18.85 inches.

i. Remove seal from turbopump inlet flange.

j. Make sure turbopump inlet and flange are clean and free of damage.

k. Install split barrel EWR 915725 on turbopump inlet flange using bolts.

l. Install plate EWR 915726 on split barrel using bolts.

m. Install Teflon sheet on plate.

n. Install fuel duct plate EWR 972057 on lower fuel inlet duct flange. Secure plate to duct with pressure-sensitive tape RB0195-002 (Rocketdyne).

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

o. Loosen 3 turnbuckles evenly, in small increments, so that fuel inlet duct flange contacts turbopump inlet flange.

p. Using Stage Contractor procedures, remove bolts that secure fuel inlet duct to customer connect flange.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

q. Support inlet duct and compress duct by tightening the 3 turnbuckles evenly, in small increments, until seal at customer connect flange can be removed. Do not compress duct to less than 18.85 inches.

r. Remove seal from customer connect flange.

s. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange and customer connect flange. Fasten in place with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

t. Support inlet duct and install spacer between customer connect flange and inlet duct flange.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

u. Support inlet duct and extend and remove turnbuckles from duct.

v. Install handler on hoist with end marked TANK END up; then, using hoist to manipulate handler, attach handler to duct as follows:

(1) Rotate knurled nuts (2 places) to retract supports.

(2) At end of handler marked TANK END, make sure pivoted lock is rotated and secured, to prevent obstruction of handler opening.

(3) Place slide arm in extreme outward position and secure with ball-lock pin.

(4) With handler oriented with adapter socket toward ECA, place handler on duct, making sure notches in top and bottom end plates engage lugs at bipod attach fittings.

(5) Move slide arm into position and secure with ball-lock pin.

(6) Rotate and secure pivoted lock.

(7) Extend supports by rotating knurled nuts until positive engagement is made with duct.

w. Compress duct to maximum allowed by handler, and remove spacer installed in step t.

NOTE

The engine must be manually gimbaled to provide enough clearance to remove the fuel inlet duct. To gimbal the engine, the stage hydraulic bypass system must be used to unlock hydraulic pressure.

x. Using stage procedures, manually gimbal engine 2-3 degrees in appropriate direction to allow fuel inlet duct removal.

NOTE

The weight of the fuel inlet duct (exclusive of handler) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

- The inlet duct should move outward and upward on a line radially from the axis. The boom head will have to be rotated to rotate the duct counterclockwise along its vertical axis.

y. Operate hoist to raise and move fuel inlet duct clear of Teflon sheet and customer connect flange, taking care not to bump or otherwise damage sealing surfaces.

z. Remove Teflon sheet, plate, and split barrel from turbopump inlet flange.

aa. Make sure turbopump inlet and flange are clean and free of damage.

ab. Install fuel pump inlet flange adapter on fuel turbopump inlet using 6 bolts and washers. Torque bolts to 25-30 in-lb.

ac. Install pump inlet closure (paragraph 3-258) on adapter using 8 screws and washers.

ad. Remove Aclar film and tape from customer connect flange and install protective closure as specified in Stage Contractor procedures.

ae. Remove Aclar film and tape from upper flange of fuel inlet duct and install plate and inlet ducts closure (paragraph 3-258) using 12 screws and washers.

af. Remove fuel duct plate EWR 972057 from lower flange of fuel inlet duct and install plate RK395-52111 (paragraph 3-258) using 12 screws and washers.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less then 18.85 inches since damage can result.

ag. Remove handler, and using turnbuckles to adjust length of fuel inlet duct, install fuel inlet duct supports (minimum of 2) on inlet duct with hand knobs to left side of bipods when duct is viewed from inlet end.

ah. Remove turnbuckles from inlet duct bipods.

ai. Make sure inlet duct covers and inlet duct pads are installed.

aj. Using hoist, move fuel inlet duct to an accessible area near stage access door.

ak. Manually transport duct through stage access door and place duct into components handling cart. If fuel inlet duct was removed to remove fuel turbopump, inlet duct may remain within stage if placed on a protective pad.

3-63. INSTALLING FUEL INLET DUCT (ENGINE HANDLER). (See figure 3-17.)

a. Obtain the following:

(1) Aclar No. 33C film (Allied Chemical Corp).

(2) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(3) Fuel inlet duct supports RK395-44101, -011, -021, and/or -031.

(4) Propellant inlet duct sling 9024400.

(5) Torque wrench adapter T-5040045.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure inlet duct covers are installed on inlet duct bellows.

d. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

e. Check fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

f. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

g. Remove inlet duct pads from inlet duct bipods.

h. Remove plate (paragraph 3-257) from lower flange of inlet duct.

i. Make sure inside of duct and sealing surfaces are clean and free of damage.

j. Loosely install double thickness of Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange so that Aclar film will not tear when duct is fitted over turbopump inducer nut. Fasten with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

k. Install bonding jumper at each end of inlet duct using screws and washers.

l. Remove pump inlet closure and fuel pump inlet flange adapter (paragraph 3-257) from turbopump inlet flange.

m. Make sure turbopump inlet and flange are clean and free of damage.

n. Install double thickness of Aclar No. 33C film (Allied Chemical Corp) over turbopump inducer nut, inducer shroud, and inlet flange. Fasten with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

CAUTION

The fuel inlet duct supports must be in place when using the propellant inlet duct sling to prevent damage to the fuel inlet duct.

o. Install propellant inlet duct sling on fuel inlet duct by looping 3 straps through inlet duct bipods. Connect snap fasteners.

CAUTION

The turbopump inducer extends beyond the pump inlet flange 4 inches and can be damaged if struck by the fuel inlet duct.

NOTE

The weight of the fuel inlet duct (exclusive of supports) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

p. Attach hoist to sling, and carefully position inlet duct over fuel turbopump so that inlet duct pin will aline with hole in turbopump inlet flange.

q. Remove Aclar film and tape from inlet duct flange.

r. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

s. Remove Aclar film and tape from turbopump inlet flange.

t. Make sure turbopump inlet and flange sealing surfaces are clean and free of damage.

u. Place seal on turbopump inlet flange.

CAUTION

The turbopump inducer extends beyond the pump inlet flange 4 inches and can be damaged if struck by the fuel inlet duct.

NOTE

The weight of the fuel inlet duct (exclusive of turnbuckles) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

v. Lower and carefully position inlet duct on turbopump inlet flange so that inlet duct pin alines with hole in turbopump inlet flange.

w. Install bolts and washers that secure inlet duct to turbopump inlet flange, attaching fuel pump accelerometer mount and bonding jumper from inlet duct. (On engines not incorporating MD233 change, transducer and bracket are also attached to turbopump inlet flange with these bolts.)

x. Torque bolts to 200 ±10 in-lb and safetywire. Use torque wrench adapter only when necessary.

y. Remove sling from fuel inlet duct.

z. Refer to section IV for test requirements.

3-64. INSTALLING FUEL INLET DUCT (UNSTACKED STAGE). (See figure 3-17.) The fuel inlet duct may be reinstalled or replaced on SII-stage engine positions 1 through 4 and on the SIVB-stage engine. Installation of the fuel inlet duct on engine position 5 must be accomplished in accordance with applicable Stage Contractor procedures.

a. Obtain the following:

(1) Aclar No. 33C film (Allied Chemical Corp).

(2) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(3) Inlet duct support frame installing tool kit 9025150.

(4) Torque wrench adapter T-5040045.

(5) Split barrel EWR 915725.

(6) Plate EWR 915726.

(7) Teflon sheet EWR 915729.

(8) Fuel duct plate EWR 972057.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure inlet duct covers are installed on inlet duct bellows.

d. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

e. Check fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

f. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

g. Remove inlet duct pads from bipods.

h. Remove inlet duct closures and plate (paragraph 3-257) from upper flange of inlet duct.

i. Make sure inside of duct and sealing surfaces are clean and free of damage.

j. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange. Fasten with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

k. Remove plate (paragraph 3-257) from lower flange of inlet duct.

l. Make sure inside of duct and sealing surfaces are clean and free of damage.

m. Install and secure plate EWR 972057 on lower flange of inlet duct, using holding springs or other provided fasteners.

n. Install bonding jumper at each end of inlet duct using screws and washers.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

o. Install the 3 turnbuckles 9026636 from inlet duct support frame installed tool kit 9025150 on inlet duct bipods.

p. Adjust the 3 turnbuckles evenly, in small increments, to remove tension or compression load on inlet duct support pin adapters, and remove fuel inlet duct supports.

q. Remove protective closure from customer connect flange.

r. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

s. Install protective material on customer connect flange.

t. Remove pump inlet closure and fuel pump inlet flange adapter (paragraph 3-257) from turbopump inlet flange.

u. Make sure turbopump inlet and flange are clean and free of damage.

v. Install 2 halves of split barrel EWR 915725 on turbopump inlet flange using bolts.

w. Install plate EWR 915726 on split barrel using bolts.

x. Place Teflon sheet on plate.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

y. Tighten the 3 turnbuckles evenly, in small increments, compressing inlet duct for insertion between customer connect flange and Teflon sheet on turbopump inlet flange. Do not compress inlet duct to less than 18.85 inches.

NOTE

The engine may be gimbaled to provide clearance to install the inlet duct. To gimbal the engine, the stage hydraulic bypass system must be used to unlock hydraulic pressure.

z. Using stage procedures, manually gimbal engine 2-3 degrees in appropriate direction to allow maximum clearance for installing fuel duct.

NOTE

The weight of the fuel inlet duct (exclusive of turnbuckles) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

aa. Using suitable equipment, raise and position fuel inlet duct on Teflon sheet on turbopump inlet flange and aline inlet duct flange pin with hole in turbopump inlet flange. Take care not to bump or otherwise damage sealing surfaces. With fuel duct in place, return engine to neutral gimbal position.

ab. Remove protective material from customer connect flange.

ac. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

ad. Remove Aclar film and tape from upper flange of inlet duct.

ae. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

af. Place seal on upper flange of inlet duct.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

ag. Loosen the 3 turnbuckles evenly, in small increments, so that fuel inlet duct flange contacts customer connect flange.

ah. Make sure inlet duct flange pin will seat in hole in turbopump inlet flange.

ai. Connect inlet duct and interface duct support struts to customer connect flange as specified in Stage Contractor procedures. Make sure bonding jumper from inlet duct is installed under one flange bolt. Remove lifting equipment from duct.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

aj. Tighten the 3 turnbuckles evenly, in small increments, compressing inlet duct enough to provide clearance to install seal. Inlet duct must not be compressed to less than 18.85 inches.

ak. Remove fuel duct plate EWR 972057 from lower flange of inlet duct flange.

al. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

am. Remove Teflon sheet, plate, and split barrel from turbopump inlet flange.

an. Make sure turbopump inlet and flange sealing surfaces are clean and free of damage.

ao. Place seal on turbopump inlet flange.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

ap. Loosen the 3 turnbuckles evenly, in small increments, until inlet duct flange contacts turbopump inlet flange and making sure that inlet duct flange pin seats in hole in turbopump inlet flange.

aq. Remove the 3 turnbuckles from inlet duct bipods.

ar. Install bolts and washers that secure inlet duct to turbopump inlet flange, attaching fuel pump accelerometer mount and bonding jumper from inlet duct. (On engines not incoporating MD233 change, transducer and bracket are also attached to the turbopump inlet flange with these bolts.)

as. Torque bolts to 200 ±10 in-lb and safetywire. Use torque wrench adapter only when necessary.

at. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

au. Check fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

av. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

aw. Refer to section IV for test requirements.

3-65. INSTALLING FUEL INLET DUCT (STACKED SII STAGE). The fuel inlet duct may be reinstalled or replaced on engines in positions 1 through 4 in the stacked SII stage. This procedure is for installing the fuel inlet duct on engines in positions 1 through 4 only. Install fuel inlet duct on engines in position 5 in accordance with applicable Stage Contractor procedures. The procedure in paragraph 3-64, Installing Fuel Inlet Duct (Unstacked Stage), may be used if additional provisions are made to protect personnel from injury and equipment from damage in a stacked stage.

a. Obtain the following: (Items 10 through 13) are not required, if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Aclar No. 33C film (Allied Chemical Corp).

(2) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(3) Fuel duct plate EWR 972057.

(4) Fuel inlet duct handler 9016784.

(5) Component handler adapter 9027174 from Engine Components Installer G4071, shelf 2.

(6) Split barrel EWR 915725.

(7) Plate EWR 915726.

(8) Teflon sheet EWR 915729.

(9) Torque wrench adapter T-504005.

(10) Chain-hoist 9027095 from engine components installer set 9026251.

(11) Component handler universal lifting sling 9016779.

(12) Universal joint S8 from engine components installer set 9026251.

(13) Extension bar SX-24 from engine components installer set 9026251.

(14) Component handling cart 9026253-11 from engine components installer set 9026251.

(15) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure inlet duct covers are installed on inlet duct bellows.

d. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

e. Check fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

f. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

g. Remove inlet duct pads from inlet duct bipods.

h. If supports are installed on fuel inlet duct, remove supports as follows:

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

(1) Using turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150, install turnbuckles on fuel inlet duct bipods.

(2) Adjust turnbuckles to remove tension or compression load on inlet duct support pin adapters, and remove supports. (The turnbuckles can be removed one at a time to facilitate removal of each support; then reinstall turnbuckle before removing next support.)

i. After removal of supports, extend and remove turnbuckles from inlet duct bipods.

j. Remove inlet ducts closure (paragraph 3-257) from upper flange of inlet duct.

k. Make sure inside of duct and sealing surfaces are clean and free of damage.

l. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange. Fasten with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

m. Remove plate (paragraph 3-257) from lower flange of inlet duct.

n. Make sure inside of duct and sealing surfaces are clean and free of damage.

o. Install fuel duct plate EWR 972057 on lower flange of inlet duct. Secure plate to duct with pressure-sensitive tape RB0195-002 (Rocketdyne).

p. Install bonding jumper at each end of inlet duct using screws and washers.

q. Install handler on fuel inlet duct as follows:

(1) Rotate knurled nuts (2 places) to retract supports.

(2) At end of handler marked TANK END, make sure pivoted lock is rotated and secured, to prevent obstruction of handler opening.

(3) Place slide arm in extreme outward position and secure with ball-lock pin.

(4) Place handler on duct, positioning handler with adapter socket approximately 70 degrees counterclockwise (as viewed from turbopump end of duct) from alinement pin on fuel inlet duct turbopump flange.

(5) Move slide arm into position and secure with ball-lock pin.

(6) Rotate and secure pivoted lock.

(7) Extend supports by rotating knurled nuts until positive engagement is made with duct.

r. Compress fuel inlet duct to maximum allowed by handler.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps s through x.

s. Install component handler universal lifting sling on duct handler and secure with ball-lock pin.

t. Position hoist on track near stage access door, and install chain-hoist on hoist boom.

u. Move hoist boom through stage access door, and lower hoist hook and attach to sling lifting ring.

NOTE

The weight of the fuel inlet duct (exclusive of handler) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

v. Raise duct and transfer through stage access door, and place duct on protective pad.

w. Remove sling from duct handler.

x. Remove chain-hoist from hoist boom.

y. Install adapter on hoist boom in position shown in figure 3-6, view F.

z. Connect handler to boom, and position hoist at track station 4.5.

aa. Remove protective closure from customer connect flange.

ab. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

ac. Install protective material on customer connect flange.

ad. Remove pump inlet closure and fuel pump inlet flange adapter (paragraph 3-257) from turbopump inlet flange.

ae. Make sure turbopump inlet and flange are clean and free of damage.

af. Install split barrel EWR 915725 on turbopump inlet flange using bolts.

ag. Install plate EWR 915726 on split barrel using bolts.

ah. Place Teflon sheet on plate.

NOTE

The weight of the fuel inlet duct (exclusive of turnbuckles) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

ai. Using hoist, position fuel inlet duct on Teflon sheet and aline inlet duct flange pin with hole in turbopump inlet flange.

aj. Remove protective material from customer connect flange.

ak. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

al. Remove Aclar film and tape from upper flange of inlet duct.

am. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

an. Place seal on upper flange of inlet duct.

ao. Release compression on inlet duct by extending handler.

ap. Make sure inlet duct flange pin will seat in hole in turbopump inlet flange.

aq. Connect inlet duct to customer connect flange as specified in Stage Contractor procedures, making sure that bonding jumper from inlet duct is installed under one bolt.

ar. Compress fuel inlet duct to maximum allowed by handler.

as. Remove fuel duct plate EWR 972057 from inlet duct flange.

at. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

au. Remove Teflon sheet, plate, and split barrel from turbopump inlet flange.

av. Make sure turbopump inlet and flange sealing surfaces are clean and free of damage.

aw. Place seal on turbopump inlet flange.

ax. Release compression on inlet duct by extending handler until inlet duct flange contacts turbopump inlet flange, making sure that inlet duct flange pin seats in hole in turbopump inlet flange.

ay. Remove handler from fuel inlet duct.

az. Install bolts and washers that secure inlet duct to turbopump inlet flange, attaching fuel pump accelerometer mount and bonding jumper from inlet duct. (On engines not incorporating MD233 change, transducer and bracket are also attached to turbopump inlet flange with these bolts.)

ba. Torque bolts to 200 ±10 in-lb and safetywire. Use torque wrench adapter only when necessary.

bb. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

bc. Check fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

bd. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

be. Disassemble track. (Refer to section V.)

bf. Refer to section IV for test requirements.

3-66. INSTALLING FUEL INLET DUCT (STACKED SIVB STAGE). The procedure in paragraph 3-64, Installing Fuel Inlet Duct (Unstacked Stage), may be used if additional provisions are made to protect personnel from injury and equipment from damage in a stacked stage.

a. Obtain the following:

(1) Inlet duct support frame installing tool kit 9025150.

(2) Aclar No. 33C film (Allied Chemical Corp).

(3) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(4) Fuel duct plate EWR 972057.

(5) Fuel inlet duct handler 9016784.

(6) Split barrel EWR 915725.

(7) Plate EWR 915726.

(8) Teflon sheet EWR 915729.

(9) Torque wrench adapter T-5040045.

(10) Spacer, 2 ±1/8 inches thick. (Spacer is required to keep duct in compressed attitude to permit removal of handler. Configuration of spacer must allow insertion at customer connect flange. Spacer may be made of any material that will not cause contamination or damage sealing surfaces and can withstand duct compression forces of 480 lb/in. (maximum) of duct compression.)

(11) Component handling cart 9026253-11 from engine components installer set 9026252.

(12) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026252 (required for use on launch tower umbilical arm).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure inlet duct covers are installed on inlet duct bellows.

d. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

e. Check fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

f. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

g. Remove inlet duct pads from inlet duct bipods.

NOTE

The weight of the fuel inlet duct (exclusive of supports) is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

h. If fuel inlet duct is outside of stage, manually transport duct to stage using cart and transfer duct into stage. Place duct on protective pad in an area accessible to hoist.

i. Remove inlet ducts closure (paragraph 3-257) from upper flange of inlet duct.

j. Make sure inside of duct and sealing surfaces are clean and free of damage.

k. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange. Fasten with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

l. Remove plate (paragraph 3-257) from lower flange of inlet duct.

m. Make sure inside of duct and sealing surfaces are clean and free of damage.

n. Install fuel duct plate EWR 972057 on lower flange of inlet duct. Secure plate to duct with pressure-sensitive tape RB0195-002 (Rocketdyne).

o. Install bonding jumper at each end of inlet duct using screws and washers.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

p. Install the 3 turnbuckles 9026636 from Inlet Duct Support Frame Installing Tool Kit 9025150 on inlet duct bipods.

q. Adjust the 3 turnbuckles evenly, in small increments, to remove tension or compression load on inlet duct support pin adapters, and remove fuel inlet duct supports.

r. Remove the 3 turnbuckles from fuel inlet duct.

s. Install handler on fuel inlet duct as follows:

(1) Rotate knurled nuts (2 places) to retract supports.

(2) At end of handler marked TANK END, make sure pivoted lock is rotated and secured, to prevent obstruction of handler opening.

(3) Place slide arm in extreme outward position and secure with ball-lock pin.

(4) Place handler on duct, positioning handler with adapter socket approximately 70 degrees counterclockwise (as viewed from turbopump end of duct) from alinement pin on fuel inlet duct turbopump flange.

(5) Move slide arm into position and secure with ball-lock pin.

(6) Rotate and secure pivoted lock.

(7) Extend supports by rotating knurled nuts until positive engagement is made with duct.

t. Remove protective closure from customer connect flange.

u. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

v. *Install protective material on customer* connect flange.

w. Remove pump inlet closure and fuel pump inlet flange adapter (paragraph 3-257) from turbopump inlet flange.

x. Make sure turbopump inlet and flange are clean and free of damage.

y. Install split barrel EWR 915725 on turbopump inlet flange using bolts.

z. Install plate EWR 915726 on split barrel using bolts.

aa. Place Teflon sheet on plate.

ab. Compress fuel inlet duct to maximum allowed by handler.

ac. Connect handler to hoist, and using hoist, orient duct for installation. To properly orient duct, position hoist so that boom extends toward fuel turbopump from ECA side of engine.

NOTE

The engine must be manually gimbaled to provide enough clearance to install the fuel inlet duct. To gimbal the engine, the stage hydraulic bypass system must be used to unlock hydraulic pressure.

ad. Using stage procedures, manually gimbal engine 2-3 degrees in direction necessary to provide clearance for fuel inlet duct installation.

NOTE

The weight of the fuel inlet duct (exclusive of turnbuckles) is 111 pounds, *or 136 pounds if the Haynes 25* (L605) bellows are incorporated.

ae. Using hoist, raise and position fuel inlet duct on Teflon sheet and aline inlet duct flange pin with hole in turbopump inlet flange. Make certain inlet duct clears inducer nut, taking care not to bump or otherwise damage sealing surfaces. With fuel duct in place, allow engine to return to zero-degree gimbal position.

af. Place spacer on inlet duct flange, and release tension on inlet duct bellows by extending handler.

ag. Support inlet duct and remove handler from duct, using hoist to support weight of handler.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

ah. Install 3 turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150 on duct.

ai. Using turnbuckles, compress duct sufficiently to loosen spacer. Remove spacer.

aj. Remove protective material from customer connect flange.

ak. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

al. Remove Aclar film and tape from upper flange of inlet duct.

am. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

an. Place seal on upper flange of inlet duct.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

ao. Loosen the 3 turnbuckles evenly, in small increments, so that fuel inlet duct flange contacts customer connect flange.

ap. Make sure inlet duct flange pin will seat in hole in turbopump inlet flange.

aq. Connect inlet duct to customer connect flange as specified in Stage Contractor procedures, making sure that bonding jumper from inlet duct is installed under one bolt.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

ar. Tighten the 3 turnbuckles evenly, in small increments, compressing inlet duct enough to provide clearance to install seal. Do not compress inlet duct to less than 18.85 inches.

as. Remove fuel duct plate EWR 972057 from inlet duct flange.

at. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

au. Remove Teflon sheet, plate, and split barrel from turbopump inlet flange.

av. Make sure turbopump inlet and flange sealing surfaces are clean and free of damage.

aw. Place seal on turbopump inlet flange.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

ax. Loosen the 3 turnbuckles evenly, in small increments, until inlet duct flange contacts turbopump inlet flange, making sure that inlet duct flange pin seats in hole in turbopump inlet flange.

ay. Remove the 3 turnbuckles from inlet duct bipods.

az. Install bolts and washers that secure inlet duct to turbopump inlet flange, attaching fuel pump accelerometer mount and bonding jumper from inlet duct. (On engines not incorporating MD233 change, transducer and bracket are also attached to the turbopump inlet flange with these bolts.)

ba. Torque bolts to 200 ±10 in-lb and safetywire. Use torque wrench adapter only when necessary.

bb. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

bc. Check fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

bd. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

be. Disassemble track. (Refer to section V.)

bf. Refer to section IV for test requirements.

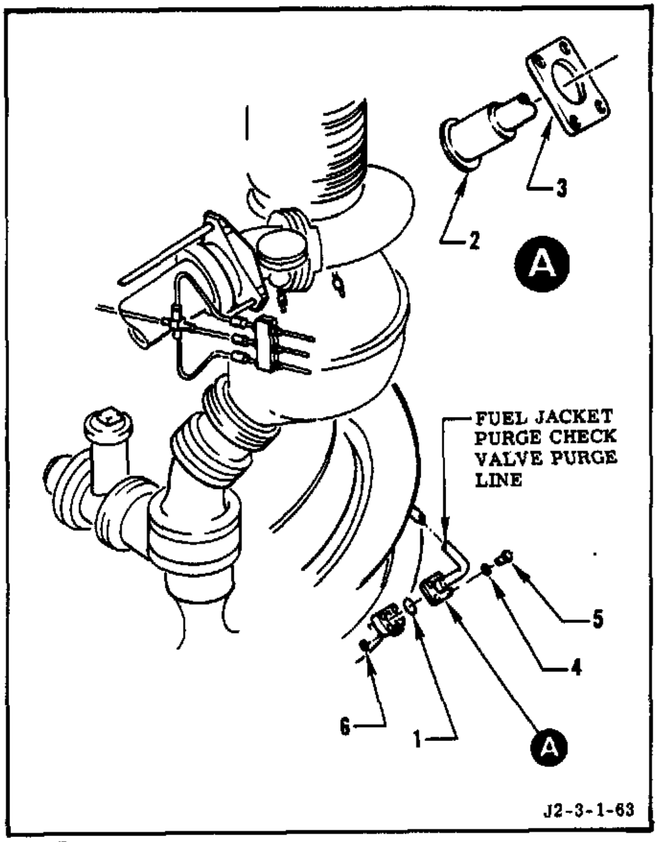
3-67. FUEL JACKET PURGE CHECK VALVE.

3-68. REMOVING FUEL JACKET PURGE CHECK VALVE. (See figure 3-18.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Cut fuel jacket purge check valve purge line. (Refer to section VI for tube cutting requirements.) Protect open lines.

c. Remove nut (6), bolt (5), washer (4), ring (3), check valve (2), and seal (1). Install clean protective closures (paragraph 3-258) on check valve and mating port of engine.



Index No.	Description
1	Seal
2	Check valve
3	Ring
4	Washer
5	Bolt
6	Nut

Figure 3-18. Fuel Jacket Purge Check Valve

3-69. INSTALLING FUEL JACKET PURGE CHECK VALVE. (See figure 3-18.)

a. If check valve is being replaced, verify that fuel jacket purge check valve preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from check valve and mating port of engine. Make sure check valve and engine mating surfaces are clean and free of damage, and valve is OK to install.

c. Install seal (1), check valve (2), and ring (3) and secure with washers (4), bolts (5), and nuts (6). Torque bolts (5) to 47-52 in-lb.

d. Weld (section VI) fuel jacket purge check valve purge line.

e. Refer to section IV for test requirements.

3-70. FUEL TURBINE EXHAUST DUCT.

3-71. REMOVING FUEL TURBINE EXHAUST DUCT (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-19.)

NOTE

If the engine is in an unstacked stage, suitable handling equipment must be provided to support and lift the duct.

a. Obtain lifting sling 9016780.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove OTBV (paragraph 3-228).

d. Remove all but 3 equally spaced bolts from flanges that secure fuel turbine exhaust duct to fuel turbopump and oxidizer turbopump.

e. Install lifting sling on duct.

f. When engine is on handler, support weight of duct (approximately 73 pounds) at fuel turbopump with hoist. If engine is in unstacked stage, use suitable handling equipment. Remove remaining bolts that secure duct to fuel turbopump.

CAUTION

Movement of the exhaust duct must be manually restrained to prevent damage to the duct or engine.

g. Manually support weight of duct at oxidizer turbopump by using sling, and remove remaining bolts that secure duct to fuel and oxidizer turbopump.

h. Move duct clear of engine, and install clean protective closures (paragraph 3-258).

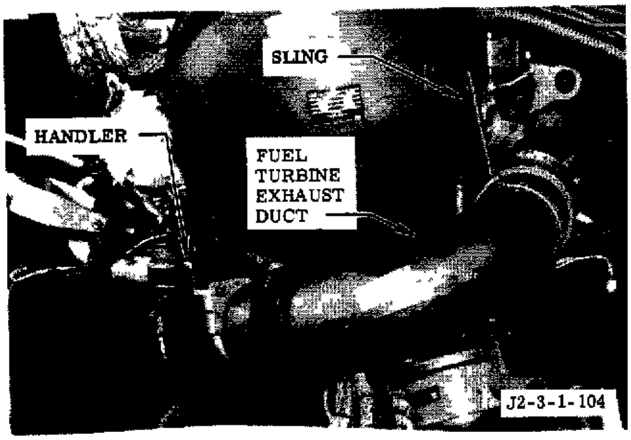


Figure 3-19. Fuel Turbine Exhaust Duct

i. If duct is going to be replaced, remove the following plugs and retain for installation on replacement duct:

(1) Plug and bleeders in instrumentation port plugs TG2 and TGT2, in fuel turbopump torque access plug, in flange seal port, in exhaust duct drain port plug, and on engines incorporating MD237 change, TGT6 and TG8

(2) Instrumentation port plugs TG2, TGT2, and on engines not incorporating MD237 change, TGT6 and TG8

(3) Fuel turbopump torque access plug and exhaust duct drain port plug

3-72. REMOVING FUEL TURBINE EXHAUST DUCT (STACKED SII STAGE). (See figure 3-19.)

a. Obtain the following: (Items 3 through 6 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Fuel exhaust duct handler 9025874 from Engine Components Installer G4071, shelf 3

(2) Sling 6001-5-5 from Engine Components Installer G4071, shelf 3

(3) Component handler universal lifting sling 9016779

(4) Chain-hoist 9027095 from engine components installer set 9026251

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Components handling cart 9026253-11 from engine components installer set 9026251

(8) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track (section V) around engine position from which turbine duct is to be removed. If task is to be performed on engine position 5 (center), install heat shield support turnbuckle. (Refer to section V.) Install turntable with controls trailing for engine positions 1 through 4, and leading for engine position 5. Position hoist 26-30 inches ahead of track station 1 on track section 9027151 for engine positions 1 through 4, and at track station 2 on track section 9027157 for engine position 5.

d. Remove OTBV (paragraph 3-228).

e. Remove all but 3 equally spaced bolts from flanges that secure turbine exhaust duct to fuel turbopump and oxidizer turbopump.

f. Install handler and sling on fuel turbine exhaust duct.

g. Attach boom to handler and secure with ball-lock pin.

h. Support weight of duct at fuel turbopump with hoist, remove remaining bolts, and secure duct to fuel turbopump.

CAUTION

Movement of the exhaust duct must be manually restrained to prevent damage to the duct or engine.

i. Manually support weight of duct at oxidizer turbopump by using sling, and remove remaining bolts that secure duct to oxidizer turbopump.

j. Move duct clear of engine, and install clean protective closures (paragraph 3-258) on all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps l through o; otherwise, omit step k.

k. Using hoist, transfer duct through stage access door and lower on to component handling cart.

l. Using hoist, transfer duct by stage access door and place duct on protective pad.

m. Install component handler universal lifting sling on handler.

n. Install chain-hoist on boom, and attach hook to sling.

o. Using hoist, slowly raise and transfer duct through stage access door and lower onto component handling cart. Guide duct through door and onto cart using sling 6001-5-5.

p. If duct is going to be replaced, remove the following plugs and retain for installation on replacement duct:

(1) Plug and bleeders in instrumentation port plugs TG2 and TGT2, in fuel turbopump torque access plug, in flange seal port, in exhaust duct drain port plug, and on engines incorporating MD237 change, TGT6 and TG8

(2) Instrumentation port plugs TG2, TGT2, and on engines not incorporating MD237 change, TGT6 and TG8

(3) Fuel turbopump torque access plug and exhaust duct drain port plug

3-73. REMOVING FUEL TURBINE EXHAUST DUCT (STACKED SIVB STAGE). (See figure 3-19.)

a. Obtain the following:

(1) Fuel exhaust duct handler 9025874 from Engine Components Installer G4072, shelf 3

(2) Sling 6001-5-5 from Engine Components Installer G4072, shelf 3

(3) Extension 9027080 from Engine Components Installer G4072, shelf 5

(4) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. See figures 5-31 and 5-32, showing required track for removal of fuel turbine exhaust duct, and install access work platform at oxidizer pump.

d. Attach sling to fuel turbine exhaust duct near oxidizer turbopump end of duct. Secure sling to prevent movement of duct.

e. Remove bolts, washers, brackets, and nuts that secure fuel turbine exhaust duct to oxidizer turbopump. Remove seal.

f. Remove access work platform, and close stage work deck.

g. Install access work platform at fuel turbopump.

h. Assemble track (section V) for fuel turbine exhaust duct removal, as required for applicable vehicle. Install turntable with controls trailing.

i. Remove OTBV (paragraph 3-228).

j. Remove all but 3 equally spaced bolts from flanges that secure fuel turbine exhaust duct to fuel turbopump.

k. Install sleeve, extension, and handler on hoist. (See figure 3-6, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

l. Manipulate hoist to lower handler through opening in which lower work platform is installed and orient handler with fuel turbine exhaust duct.

m. Attach handler to fuel turbine exhaust duct. Wrap handler straps around duct and secure.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

- Care must be used when handling the duct, to prevent unnecessary flexing of the bellows, which can damage the duct.

n. Support weight of duct (approximately 75 pounds) at fuel turbopump by manipulation of hoist and turnbuckle on extension. Make sure a minimum of one thread is evident in turnbuckle barrel when turnbuckle is extended. Make sure side load does not exist on duct.

o. Remove remaining bolts that secure duct to fuel turbopump. Remove seal.

p. Manually support end of fuel turbine exhaust duct near oxidizer turbopump and move fuel turbine exhaust duct manually and with hoist, clear of engine. Install protective closures (paragraph 3-258).

q. Remove pie-shaped sections of stage work deck. (See figure 5-31 or 5-32.)

NOTE

While removing the fuel turbine exhaust duct (step r), the access work platform may be temporarily removed to gain additional clearance.

r. Move fuel turbine exhaust duct toward end of track and raise duct through opening provided by removal of pie-shaped sections of stage work deck.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

s. Using hoist, sling, and extension turnbuckle, raise fuel turbine exhaust duct through opening provided by removal of stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the duct to the stage work deck; therefore, it may be necessary for a technician to guide the duct and to assist the hoist operator.

CAUTION

The duct must be manually supported with the sling when transferring the duct with the hoist, to prevent damage to the duct due to the excessive length.

t. Using hoist and sling, move duct to an accessible area near stage access door. Manually support duct during transfer using sling attached to duct.

u. Remove duct from hoist and temporarily place on protective pad.

v. Manually carry duct from stage. A suggested method of handling the duct is to attach slings 6001-5-3 to duct using a choker hitch.

w. If duct is going to be replaced, remove the following plugs and retain for installation on replacement duct:

(1) Plug and bleeders in instrumentation port plugs TG2 and TGT2, in fuel turbopump torque access plug, in flange seal port, in exhaust duct drain port plug, and on engines incorporating MD237 change, TGT6 and TG8

(2) Instrumentation port plugs TG2, TGT2, and on engines not incorporating MD237 change, TGT6 and TG8

(3) Fuel turbopump torque access plug and exhaust duct drain port plug

3-74. INSTALLING FUEL TURBINE EXHAUST DUCT (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-19.)

NOTE

If the engine is in an unstacked stage, suitable handling equipment must be provided to support and lift the duct.

a. Obtain lifting sling 9016780.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure fuel turbine exhaust duct, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Install lifting sling 9016780, if required, on fuel turbine exhaust duct for supporting and installing exhaust duct.

WARNING

Failure to provide adequate support and handling equipment for the duct can result in injury to personnel and damage to equipment.

e. When engine is on handler, support weight of duct at fuel turbopump with hoist, or if engine is in unstacked stage, use suitable handling equipment. Support weight of duct (approximately 73 pounds) at oxidizer turbopump manually by using sling and move fuel turbine exhaust duct into position on engine.

f. Remove protective material from fuel turbopump and fuel turbine exhaust duct flanges, install seal between flanges, and secure flanges with bolts, washers, brackets, and nuts. Cross-torque bolts to 138-152 in-lb.

g. Remove protective material from oxidizer turbopump and fuel turbine exhaust duct flanges, install seal between flanges, and secure flanges with bolts, washers, brackets, and nuts. Cross-torque bolts to 119-131 in-lb.

h. Install OTBV (paragraph 3-229).

i. Remove lifting sling from duct.

j. If duct was replaced, remove protective material from ports, and install the following plugs and seals:

(1) Exhaust duct drain port plug. Torque to 67-73 in-lb.

(2) Fuel turbopump torque access plug. Torque to 405-445 in-lb.

(3) Instrumentation port plugs TG2, TGT2, and on engines not incorporating MD237 change, TGT6 and TG8. Torque to 67-73 in-lb.

(4) Plug and bleeders in instrumentation port plugs TG2 and TGT2, in fuel turbopump torque access plug, in flange seal port plug, in exhaust duct drain port plug, and on engines not incorporating MD237 change, TGT6 and TG8. Torque to 22-28 in-lb.

k. Refer to section IV for test requirements:

3-75. INSTALLING FUEL TURBINE EXHAUST DUCT (STACKED SII STAGE). (See figure 3-19.)

a. Obtain the following: (Items 4 through 7 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Fuel exhaust duct handler 9025874 from Engine Components Installer G4071, shelf 3

(2) Sling 6001-5-5 from Engine Components Installer G4071, shelf 3

(3) Component handler universal lifting sling 9016779

(4) Chain-hoist 9027095 from engine components installer set 9026251

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Components handling cart 9026253-11 from engine components installer set 9026251

(8) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure fuel turbine exhaust duct, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Install handler and sling on fuel turbine exhaust duct.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps e through j.

e. Install sling on duct handler and secure with ball-lock pin.

f. Position hoist near stage access door, and install chain-hoist on hoist boom.

g. Move hoist boom through stage access door, lower hoist hook, and attach hook to sling lifting ring.

CAUTION

Movement of the exhaust duct must be manually restrained to prevent damage to the duct or engine.

h. Raise weight of duct (approximately 73 pounds) using hoist boom. Guide duct with sling 6001-5-5 through stage access door and place duct on protective pad.

i. Remove sling from duct handler.

j. Remove chain-hoist from hoist boom.

k. Attach boom to handler and secure with ball-lock pin.

l. Position hoist 26-30 inches ahead of track station 1 on track section 9027151 for engine positions 1 through 4, and at track station 2 on track section 9027157 for engine position 5.

m. Support weight of duct at fuel turbopump with hoist and manually support weight of duct at oxidizer turbopump by using sling, and move fuel turbine exhaust duct into position on engine.

n. Remove protective material from fuel turbopump and fuel turbine exhaust duct, install seal between flanges, and temporarily secure with 4 diametrically opposite bolts, washers, and nuts. Do not torque bolts at this time.

o. Remove protective material from oxidizer turbopump and fuel turbine exhaust duct, install seal between flanges, and temporarily secure with 4 diametrically opposite bolts, washers, and nuts. Do not torque bolts at this time.

p. Remove sling and handler from fuel turbine exhaust duct.

q. Disassemble track. (Refer to section V.)

r. If task is being performed on engine in position 5 (center), remove heat shield support turnbuckle and reinstall heat shield V-strut (stage) in accordance with applicable stage procedures.

s. Install remaining bolts, washers, nuts, and brackets to secure fuel turbine exhaust duct to fuel turbopump. Cross-torque bolts to 138-152 in-lb.

t. Install remaining bolts, nuts, washers, and brackets to secure fuel turbine exhaust duct to oxidizer turbopump. Cross-torque bolts to 119-131 in-lb.

u. Install OTBV (paragraph 3-229).

v. If duct was replaced, remove protective material, and install the following plugs and seals:

(1) Exhaust duct drain port plug. Torque to 67-73 in-lb.

(2) Fuel turbopump torque access plug. Torque to 405-445 in-lb.

(3) Instrumentation port plug TG2, TGT2, and on engines not incorporating MD237 change, TGT6 and TG8. Torque to 67-73 in-lb.

(4) Plug and bleeders in instrumentation port plugs TG2 and TGT2, in fuel turbopump torque access plug, in flange seal port plug, in exhaust duct drain port plug, and on engines not incorporating MD237 change, TGT6 and TG8. Torque to 22-28 in-lb.

w. Refer to section IV for test requirements.

3-76. INSTALLING FUEL TURBINE EXHAUST DUCT (STACKED SIVB STAGE). (See figure 3-19.)

a. Obtain the following:

(1) Fuel exhaust duct handler 9025874 from Engine Components Installer G4072, shelf 3

(2) Sling 6001-5-5 from Engine Components Installer G4072, shelf 3

(3) Extension 9027080 from Engine Components Installer G4072, shelf 5

(4) Sleeve 9027084 (SIB vehicle) or 9027084-11 (SV vehicle) from Engine Components Installer G4072, shelf 3

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closure (paragraph 3-257). Make sure fuel turbine exhaust duct, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

CAUTION

Care must be used when handling the duct, to prevent unnecessary flexing of the bellows, which can damage the duct.

d. Manually carry fuel turbine exhaust duct (approximately 73 pounds) into vehicle and place on protective pad. A suggested method of handling duct is to attach slings 6001-5-3 to duct using a choker hitch.

e. Install sleeve, extension, and handler on hoist. (See figure 3-6, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pins.

f. Install fuel turbine exhaust duct on handler. Wrap handler straps around duct and secure.

g. Attach sling to fuel turbine exhaust duct.

CAUTION

The duct must be manually supported with the sling when transferring the duct with the hoist, to prevent damage to the duct due to the excessive length.

h. Using hoist and manually supporting duct with sling, move duct to opening provided by removal of stage work deck pie-shaped panels. See figure (section V) that shows applicable track configuration for removing fuel turbine exhaust duct.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

i. Using hoist and manually supporting duct with sling, lower duct through opening in stage work deck. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in lowering component through stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the fuel turbine exhaust duct to the engine; therefore, it may be necessary for a technician to guide the duct and to assist the hoist operator.

CAUTION

Movement of the exhaust duct must be manually restrained to prevent damage to the duct or engine.

j. Support weight of duct at fuel turbopump with hoist and manually support weight of duct at oxidizer turbopump by using sling, and move fuel turbine exhaust duct into position on engine. Secure sling to prevent movement of duct at oxidizer turbopump.

k. Remove protective material from fuel turbopump and fuel turbine exhaust duct flanges, install seal between flanges, and secure flanges with bolts, washers, brackets, and nuts. Cross-torque bolts to 138-152 in-lb.

l. Remove handler from fuel turbine exhaust duct.

m. Remove handler, extension, and sleeve from hoist.

n. Disassemble track. (Refer to section V.)

o. Install work platform adjacent to oxidizer turbopump end of fuel turbine exhaust duct. (Refer to section V.)

p. Remove protective material from oxidizer turbopump and fuel turbine exhaust duct flanges, and install seal between flanges.

q. Install bolts, nuts, washers, and brackets to secure fuel turbine exhaust duct to oxidizer turbopump. Cross-torque bolts to 119-131 in-lb.

r. Install OTBV (paragraph 3-229).

s. Remove sling from duct.

t. If duct was replaced, remove protective material, and install the following plugs and seals:

(1) Exhaust duct drain port plug. Torque to 67-73 in-lb.

(2) Fuel turbopump torque access plug. Torque to 405-445 in-lb.

(3) Instrumentation port plug TG2, TGT2 and on engines not incorporating MD237 change, TGT6 and TG8. Torque to 67-73 in-lb.

(4) Plug and bleeders in instrumentation port plugs TG2 and TGT2, in fuel turbopump torque access plug, in flange seal port plug, in exhaust duct drain port plug, and on engines not incorporating MD237 change, TGT6 and TG8. Torque to 22-28 in-lb.

u. Refer to section IV for test requirements.

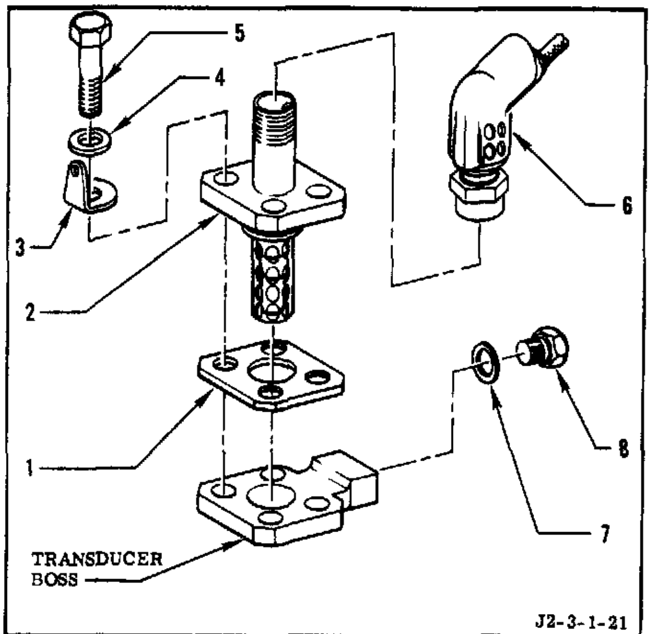
3-77. <u>FUEL TURBINE INLET, OXIDIZER TURBINE INLET, AND OXIDIZER TURBINE EXHAUST TEMPERATURE TRANSDUCERS.</u>

3-78. REMOVING FUEL TURBINE INLET, OXIDIZER TURBINE INLET, AND OXIDIZER TURBINE OUTLET TEMPERATURE TRANSDUCERS. (See figure 3-20.) The fuel turbine inlet, oxidizer turbine inlet, and oxidizer turbine outlet temperature transducers with part numbers NA5-27323T3 may be reinstalled or replaced, however, transducers with part numbers NA5-27323T6 may be replaced but must not be reinstalled.

NOTE

Installation and removal of transducers NA5-27323T6 causes deformation (canting and rounding of corners) of copper ring. The transducer must be returned to Rocketdyne for refurbishing.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.



Index No.	Description
1	Seal
2	Temperature transducer
3	Lug
4	Washer
5	Bolt
6	Electrical connector (P126, P127, or P128)
7	Gasket
8	Plug

Figure 3-20. Fuel Turbine Inlet, Oxidizer Turbine Inlet, and Oxidizer Turbine Outlet Temperature Transducers

b. Disconnect electrical connector (paragraph 3-30) P126, P127, or P128 (6).

CAUTION

Prying on the transducer flange or boss can result in damage to sealing surfaces.

c. Remove bolts (5), washers (4), and lug (3). If transducer (2) can be removed easily, remove transducer and seal (1), install clean protective closures (paragraph 3-258) on transducer and mating flange on engine, and disregard remainder of this procedure.

d. If transducer (2) cannot be easily removed, make sure an RD261-6002-XXXX cap is installed on transducer.

e. Grasp cap on transducer with connector pliers and pull straight out. If transducer cannot be removed, use an open-end wrench on transducer flange and turn just enough to loosen transducer; then remove transducer (2) by grasping cap with connector pliers and pulling straight out. Install clean protective closures (paragraph 3-258) on transducer and on mating flange on engine.

3-79. INSTALLING FUEL TURBINE INLET, OXIDIZER TURBINE INLET, AND OXIDIZER TURBINE OUTLET TEMPERATURE TRANSDUCERS. (See figure 3-20.) The fuel turbine inlet, oxidizer turbine inlet, and oxidizer turbine outlet temperature transducers with part numbers NA5-27323T3 may be reinstalled or replaced; however, transducers with part numbers NA5-27323T6 may be replaced but must not be reinstalled.

a. If transducer is being replaced, verify that temperature transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. If the transducer mounting flange on the engine requires refinishing, the following equipment is required:

(1) One polishing pad DJ-1 and 600-grit abrasive paper

(2) One electric or air-driven hand motor

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257) from transducer mating port on engine. Make sure sealing surface, threads in parent metal, and/or threaded inserts are clean and free of damage, sealing surface is flat within 0.002 inch, and threaded inserts are installed correctly (section I). If sealing surface is not damaged and is flat to within 0.002 inch, proceed to step g.

d. If sealing surface is damaged, refinish surface using electric or air-driven motor, polishing pad DJ-1, and 600-grit abrasive paper.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

e. Remove plug (8) and gasket (7), and blow grinding particles from sealing surface and from seal vent port with low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401). Protect transducer boss sealing flange.

f. Install gasket (7) and plug (8). Torque plug as follows:

(1) Fuel turbine inlet (TGT1), 65-75 in-lb.

(2) Oxidizer turbine inlet (TGT3), 22-28 in-lb

(3) Oxidizer turbine outlet (TGT4), 22-28 in-lb

g. Remove protective material, and make sure transducer and mating port is clean, free of damage, and OK to install transducer.

h. Install seal (1) and transducer (2), and position transducer (2) so key in transducer is alined with keyway in electrical connector P126, P127, or P128 (6).

i. If transducer NA5-27323T3 is being installed, proceed to step m.

j. Obtain and install 4 bolts RD111-1009-3414 in transducer flange. Tighten bolts fingertight making sure sealing surfaces of transducer flange and boss flange are parallel to within 0.033 inch.

CAUTION

Bottoming bolts in the transducer boss or exceeding 55 in-lb torque on bolts can result in damage to threads.

k. Use washers under heads of bolts, as necessary, to prevent bolts from bottoming. Alternately tighten each bolt 1/4 to 1/2 turn, not exceeding 55 in-lb of torque, until transducer is pulled into boss far enough to install 4 bolts (5).

l. Remove 4 bolts RD111-1009-3414 and washers if used.

m. Install lug (3), washers (4), and bolts (5). Tighten bolts (5) fingertight.

n. Alternately tighten bolts (5) 1/4 to 1/2 turn each until transducer flange seats seal against boss sealing surface. Torque bolts (5) as follows: (Safetywire boltheads.)

(1) Fuel turbine inlet (TGT1), 75-85 in-lb

(2) Oxidizer turbine inlet (TGT3), 45-55 in-lb

(3) Oxidizer turbine outlet (TGT4), 45-55 in-lb

o. Connect electrical connector (paragraph 3-31) P126, P127, or P128 (6).

p. Refer to section IV for test requirements.

3-80. FUEL TURBOPUMP.

3-81. REMOVING FUEL TURBOPUMP (ENGINE HANDLER OR UNSTACKED STAGE). The fuel turbopump can be removed and reinstalled but cannot be replaced without affecting engine calibration.

NOTE

If the engine is in an unstacked stage, suitable handling equipment must be provided to support and lift the turbopump, which weighs 418 pounds.

a. Obtain the following:

(1) Rotating Sling G4063 (used when engine is in handler and if pump is to be rotated after removal)

(2) Turbopump Sling G4046 (used when engine is in handler)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

When moving electrical interface support assembly, do not twist, kink, or stretch cables since damage to cables can result.

c. If engine is in handler, remove 2 bolts that secure electrical interface support assembly (GSE) to engine cable support frame. Move interface support assembly enough to provide access to remove fuel turbopump.

d. Remove electrical cable clamps and move cables as necessary to provide access for turbopump removal. Note position of clamps for reinstallation.

e. Remove fuel inlet duct (paragraph 3-58).

f. Remove OTBV (paragraph 3-228).

g. Remove fuel turbine exhaust duct (paragraph 3-70).

h. Disconnect GG control valve as follows:

(1) Remove bolts and washers that secure bracket and mainstage control manifold to control valve. Remove seal.

(2) Remove bolts and washers that secure oxidizer and fuel lines to GG control valve. Remove orifices and seals. Retain orifices for reinstallation.

i. Remove bolts and washers that secure STDV hose to fuel turbine manifold. (These bolts also retain the fuel bleed line and electrical harness brackets. Retain brackets for reinstallation.) Remove seal, and install clean protective closures (paragraph 3-258) on hose and turbine manifold.

j. Remove bolts and washers that secure fuel bleed line to fuel bleed valve. Remove seal and bracket and retain bracket for reinstallation. Protect open ports and sealing surfaces of valve and bleed line.

k. Remove bolts and washers that secure control line to fuel bleed valve. Remove seal and bracket and retain bracket for reinstallation. Protect open ports and sealing surfaces of valve and control line.

kA. On engines not incorporating MD150, MD280, or MD281 change, cut fuel turbopump discharge pressure line (PF2), and protect open end of cut lines. (Refer to section VI for tube cutting requirements.)

l. Remove bolts and washers that secure fuel high-pressure duct to turbopump fuel volute. (The fast-shutdown valve and bracket are also retained by these bolts.) Remove seal, and protect openihgs and sealing surfaces of duct and fuel volute.

m. Disconnect the following electrical connectors (paragraph 3-30): (See figure 3-21.)

(1) P112

(2) P126

(3) P141 (On engines incorporating MD233 change, connector P141 is removed.)

(4) P160

(5) P161 (On engines incorporating MD172 change, temperature probe is removed from turbopump rear bearing and connector P161 is stowed. On engines incorporating MD185 change, connector P161 is removed.)

(6) P116

n. Remove GG spark igniter cables G3 and G4. (Refer to paragraph 3-109.)

o. Cut the following lines: (See figure 3-21.) (Refer to section VI for tube cutting requirements. Cut lines on engine side of bracket, where possible, leaving approximately 3 inches of straight tube on turbopump. Protect open end of cut lines.)

(1) Fuel turbine seal drain line

(2) Fuel turbopump primary seal drain line

(3) Fuel turbine seal purge line (TG10)

(4) Fuel turbopump primary seal purge line (PF7)

(5) Fuel pump balance piston pressure line (PF5) (on engines not incorporating MD150 change)

(6) Fuel turbine inlet pressure line (TG1) (on engines not incorporating MD150 change but incorporating MD237 change)

(7) GG chamber pressure lines (GG1 and GG1a) (on engines not incorporating MD150 or MD237 change)

(8) GG fuel injector and purge line (GF4) (on engines not incorporating MD150 change)

(9) GG oxidizer injector and purge line (GO5) (on engines not incorporating MD150 change)

(10) GG equalization line

p. If engine is in engine handler, perform steps p through r and then proceed to step t. If engine is in an unstacked stage, proceed to step s.

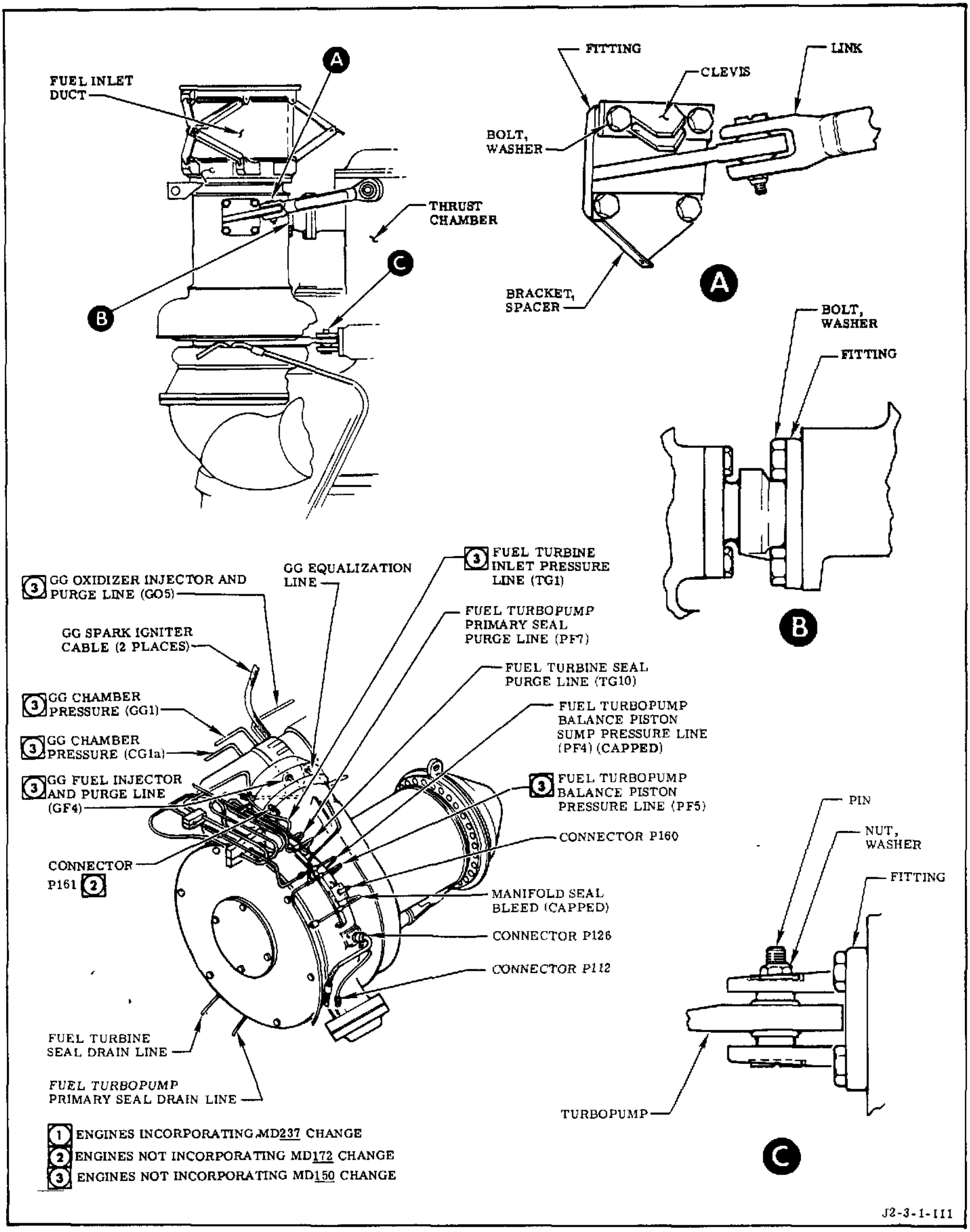


Figure 3-21. Fuel Turbopump

q. Install adapters on fuel turbopump. (See figure 3-22.) Torque bolts securing adapters to turbopump to 25-30 in-lb. Install clean protective closures (paragraph 3-258).

r. Install Rotating Sling G4063 (figure 3-22) or Turbopump Sling G4046.

s. Attach a hoist capable of lifting 500 pounds to sling.

WARNING

Failure to provide adequate support and handling equipment for turbopump can result in injury to personnel and damage to equipment.

t. Attach suitable equipment to lift and support fuel turbopump.

NOTE

The fuel turbopump weighs 418 pounds.

u. Remove nut, washer, and pin that secure fuel turbopump to thrust chamber. (See figure 3-21, detail C.)

v. Remove bolts and washers that secure clevis, fitting, spacers, and bracket to turbopump mounting pad. (See figure 3-21, detail A.)

w. Remove bolts, washers, and fitting securing fuel turbopump to thrust chamber. (See figure 3-21, detail B.)

x. Carefully remove fuel turbopump from engine.

y. Remove protective material from turbopump and engine ports, and install clean protective closures (paragraph 3-258).

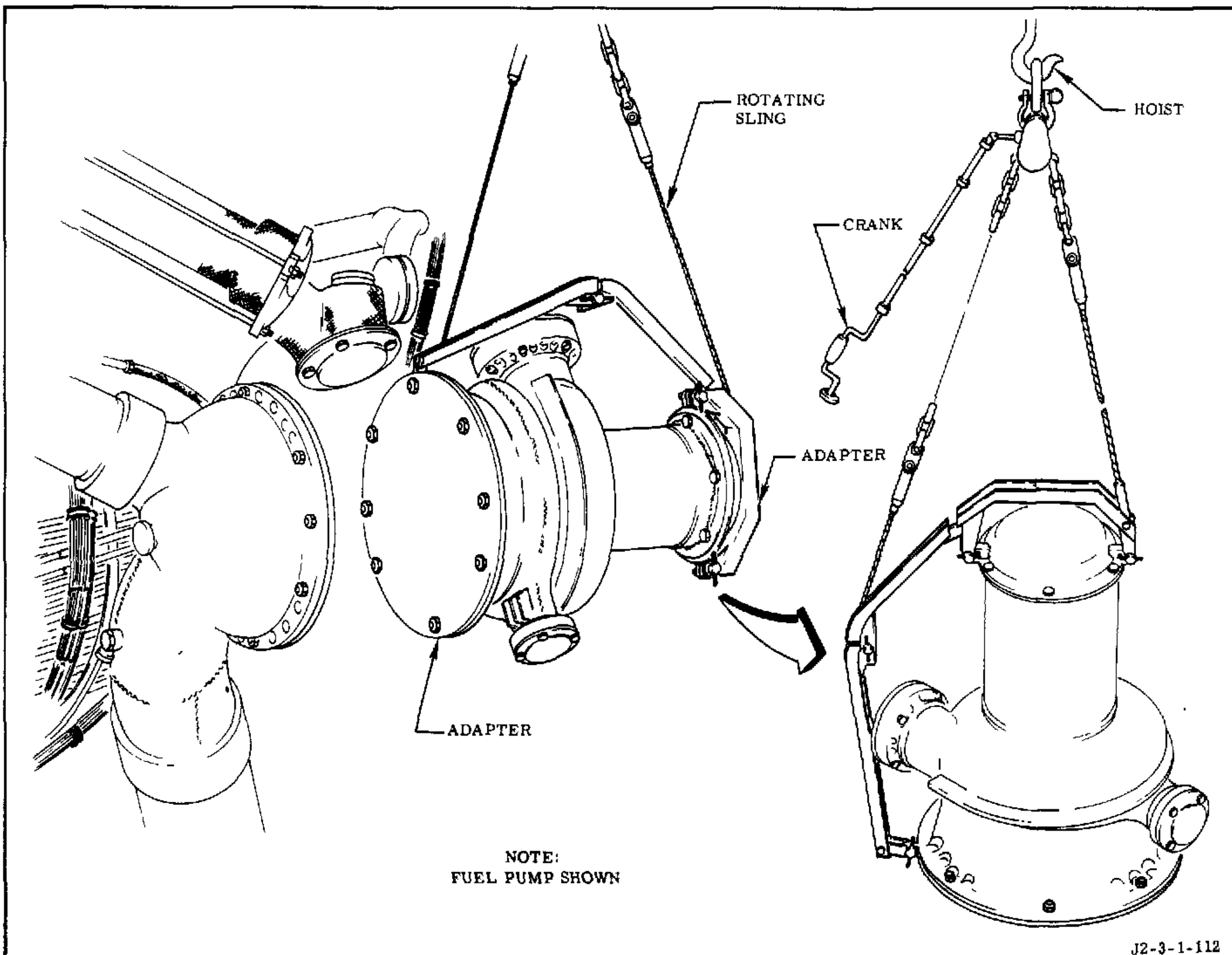


Figure 3-22. Handling Fuel and Oxidizer Turbopump

3-82. REMOVING FUEL TURBOPUMP (STACKED SII STAGE). The fuel turbopump can be removed and reinstalled but cannot be replaced without affecting engine calibration.

a. Obtain the following: (Items 4, 5, 6, 9, 10, and 11, are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Handler 9026977 from Engine Components Installer G4071, shelf 3

(2) Hook 9024600 from Engine Components Installer G4071, shelf 1

(3) Torque wrench adapter T-5040045

(4) Hanger 9024543 from engine components installer set 9026251

(5) Pickup adapter 9024547 from engine components installer set 9026251

(6) Chain-hoist 9027095 from engine components installer set 9026251

(7) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(8) Components handling cart 9026253-11 from engine components installer set 9026251

(9) Universal joint S8 from engine components installer set 9026251

(10) Extension bar SX-24 from engine components installer set 9026251

(11) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track (section V) around engine positions (1 through 5) from which fuel turbopump is to be removed. Install turntable with controls leading, and position hoist at track station 2 for engine positions 1 through 4, or track station 4 for engine position 5.

d. Remove fuel inlet duct (paragraph 3-61) from engine positions 1 through 4 or from engine position 5 using applicable Stage Contractor procedures. Install handler on fuel turbopump volute with arrow pointing toward fuel turbopump attach point and index pin engaging hole in pump flange. Place lifting eye in fuel turbopump lifting position. Using torque wrench adapter, cross-torque handler bolts to 190-210 in-lb. Install closure RX20714 on handler.

e. Remove OTBV (paragraph 3-228).

f. Remove fuel turbine exhaust duct (paragraph 3-72).

g. Disconnect GG control valve as follows:

(1) Remove bolts and washers that secure bracket and mainstage control manifold to control valve. Remove seal.

(2) Remove bolts and washers that secure oxidizer and fuel lines to GG control valve. Remove orifices and seals. Retain orifices for reinstallation.

h. Remove bolts and washers that secure STDV hose to fuel turbine manifold. (These bolts also retain the fuel bleed line and electrical harness brackets. Retain brackets for reinstallation.) Remove seal, and install clean protective closures (paragraph 3-258) on hose and turbine manifold.

i. Remove bolts and washers that secure fuel bleed line to fuel bleed valve. Remove seal and bracket, and retain bracket for reinstallation. Protect open ports and sealing surfaces of valve and bleed line.

j. Remove bolts and washers that secure control line to fuel bleed valve. Remove seal and bracket, and retain bracket for reinstallation. Protect open ports and sealing surfaces of valve and control line.

k. Remove bolts and washers that secure high-pressure duct to turbopump fuel volute. Remove seal, and protect openings and sealing surfaces of duct and volute. (The fast-shutdown valve and bracket is also retained by these bolts.)

l. Disconnect the following electrical connectors (paragraph 3-30):

(1) P112

(2) P126

(3) P141 (On engines incorporating MD233 change, connector P141 is removed.)

(4) P160

(5) P161 (On engines incorporating MD172 change, temperature probe is removed from turbopump bearing and connector P161 is stowed.)

(6) P116

m. Remove electrical cable clamps, and move cables as necessary to provide access for turbopump removal. Note position of clamps and cables for reinstallation.

n. Remove GG spark igniter cables G3 and G4. (Refer to paragraph 3-109.)

o. Cut the following lines: (See figure 3-21.) (Refer to section VI for tube cutting requirements. Cut lines on engine side of bracket, leaving approximately 3 inches of straight tube on turbopump. Protect open ends of cut lines.)

(1) Fuel turbine seal drain line

(2) Fuel turbopump primary seal drain line

(3) Fuel turbine seal purge line (TG10)

(4) Fuel turbopump primary seal purge line (PF7)

(5) Manifold seal bleed (capped)

(6) GG equalization line

p. Install hook on hoist as shown in figure 3-6, view A.

NOTE

If the launch tower umbilical arm is to be used for component removal from the stage, omit steps q and r.

q. Install pickup adapter on handler lifting eye.

r. Connect hook on hoist to pickup adapter attached to handler lifting eye on fuel turbopump volute and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

s. Connect hook on boom to handler lifting eye on fuel turbopump volute and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

t. Remove lower nut, washer, and pin that secure fuel turbopump to thrust chamber. (See figure 3-21, detail C.)

u. Remove bolts and washers that secure clevis, fitting, spacers, and bracket to turbopump mount pad. (See figure 3-21, detail A.)

v. Remove bolts and washers (on thrust chamber side of fitting) that secure fuel turbopump to thrust chamber. (See figure 3-21, detail B.)

w. Make sure fuel turbopump is free of engine; then move turbopump clear of engine.

x. Remove protective material from turbopump and engine ports, and install clean protective closures (paragraph 3-258) on all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps z through ad; otherwise, omit step y.

y. Using hoist, transfer turbopump through stage access door and slowly lower turbopump into component handling cart.

z. Using hoist, slowly move turbopump to hanger and attach to hanger using pickup adapter swivel.

aa. Remove hook from hoist.

ab. Install chain-hoist on hoist boom.

ac. Attach hoist hook to pickup adapter using a shackle and raise turbopump.

ad. Slowly move turbopump through stage access door and lower turbopump into component handling cart.

3-83. REMOVING FUEL TURBOPUMP (STACKED SIVB STAGE). The fuel turbopump can be removed and reinstalled but cannot be replaced without affecting engine calibration. Engine Components Installer G4072MD2 must be used when performing this task.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following:

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4072, shelf 3

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

(3) Pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Adapter 9026997 from engine components installer set 9026252

(6) Chain-hoist 9027095 from engine components installer set 9026252

(7) Components handling cart 9026253-11 from engine components installer set 9026252

(8) Universal joint S8 from engine components installer set 9026252

(9) Extension bar SX-24 from engine components installer set 9026252

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove OTBV (paragraph 3-228).

d. Remove fuel turbine exhaust duct (paragraph 3-73).

e. Disassemble and reassemble track (section V) for fuel turbopump removal.

f. Remove electrical cable clamps and move cables as necessary to provide access for turbopump removal. Note position of clamps and cables for reinstallation.

NOTE

It is not necessary to remove the fuel inlet duct from the stage.

g. Remove fuel inlet duct (paragraph 3-62), except do not install adapter RD295-44094-011 on fuel turbopump volute.

h. Install handler 9026977 and adapter 9026997 on fuel turbopump volute as follows:

(1) Install handler with arrow pointing toward fuel turbopump attach point and index pin engaging hole in pump flange. Place lifting eye in fuel turbopump lifting position.

(2) Using torque wrench adapter, cross-torque handler attach bolts to 190-210 in-lb.

(3) Remove screws that attach closure RX20714 to handler. Remove closure.

(4) Place adapter on closure and install closure and adapter on handler 9026977. Torque bolts to 50-70 in-lb.

(5) Make sure lifting adapter on turbopump adapter is directly above centerline chain fuel turbopump position. Remove ball-lock pin and rotate adapter, if required.

i. Disconnect GG control valve as follows:

(1) Remove bolts and washers that secure bracket and mainstage control manifold to control valve. Remove seal.

(2) Remove bolts and washers that secure oxidizer and fuel lines to GG control valve. Remove orifices and seals. Retain orifices for reinstallation.

j. Remove bolts and washers that secure STDV hose to fuel turbine manifold. (These bolts also retain the fuel bleed line and electrical harness brackets. Retain brackets for reinstallation.) Remove seal, and install clean protective closures (paragraph 3-258) on hose and turbine manifold.

k. Remove bolts and washers that secure fuel bleed line to fuel bleed valve. Remove seal and bracket, and retain bracket for reinstallation. Protect open ports and sealing surfaces of valve and bleed line.

l. Remove bolts and washers that secure control line to fuel bleed valve. Remove seal and bracket, and retain bracket for reinstallation. Protect open ports and sealing surfaces of valve and control line.

m. Remove bolts and washers that secure fuel high-pressure duct to turbopump fuel volute. (The fast-shutdown valve and bracket are also retained by these bolts.) Remove seal, and protect openings and sealing surfaces of duct and fuel volute.

n. Disconnect the following electrical connectors (paragraph 3-30): (See figure 3-21.)

(1) P112

(2) P126

(3) P141 (On engines incorporating MD233 change, connector P141 is removed.)

(4) P160

(5) P161 (On engines incorporating MD172 change, temperature probe is removed from turbopump rear bearing and connector P161 is stowed. On engines incorporating MD185 change, connector P161 is removed.)

(6) P116

o. Remove GG spark igniter cables G3 and G4. (Refer to paragraph 3-109.)

p. Cut the following lines: (See figure 3-21.) (Refer to section VI for tube cutting requirements. Cut lines on engine side of bracket, where possible, leaving approximately 3 inches of straight tube on turbopump. Cut other lines as necessary. Protect open end of cut lines.)

(1) Fuel turbine seal drain line

(2) Fuel turbopump primary seal drain line

(3) Fuel turbine seal purge line (TG10)

(4) Fuel turbopump primary seal purge line (PF7)

(5) Manifold seal bleed line (capped)

(6) GG equalization line

q. Install hook on hoist as shown in figure 3-6, view A.

r. Connect pickup adapter on hook, and secure hook latch with ball-lock pin. Support turbopump (418 pounds) using hoist.

s. Remove lower nut, washer, and pin that secure fuel turbopump to thrust chamber. (See figure 3-21, detail C.)

t. Remove bolts and washers that secure clevis, fitting, spacers, and bracket to turbopump mount pad. (See figure 3-21, detail A.)

u. Remove bolts, washers, and fitting that secure fuel turbopump to thrust chamber. (See figure 3-21, detail B.)

v. Make sure fuel turbopump is free of engine; then move turbopump (418 pounds) clear of engine.

w. Install clean protective closures (paragraph 3-258) on turbopump and all open ports on engine.

x. Assemble hanger in accessible area near stage access door.

y. Using hoist, move turbopump to hanger.

CAUTION

Raising the hoist boom above the indicated maximum height can damage equipment.

z. Raise hoist until pickup adapter engages hanger shackle. Do not raise hoist above the indicated maximum height. If pickup adapter does not engage hanger shackle with hoist adjusted to maximum, adjust boom turnbuckle until pickup adapter engages hanger shackle.

aa. Remove ball-lock pin from hook, and remove hoist from hanger.

ab. Assemble elevated track (section V) for removal of fuel turbopump from stage.

ac. Install chain-hoist on hoist and secure with ball-lock pin.

ad. Loosen internal wrenching bolt, and remove hook from chain-hoist.

ae. Move hoist into position to pick up fuel turbopump.

af. Make sure lifting adapter on turbopump adapter 9026997 is installed directly above centerline chain fuel turbopump position.

ag. Connect chain-hoist chain to lifting adapter, and torque internal wrenching bolt to 12-15 in-lb.

ah. Using hoist and chain-hoist, remove fuel turbopump from hanger.

CAUTION

The fuel turbopump must be manually restrained due to the limited access, to prevent damage to the turbopump and stage.

ai. Using hoist, move fuel turbopump through stage access door. Manually restrain movement of fuel turbopump when moving it through stage access door.

aj. Using chain-hoist and hoist, lower fuel turbopump to component handling cart.

ak. Install fuel turbopump in component handling cart, and remove chain-hoist from handler.

3-84. INSTALL FUEL TURBOPUMP (ENGINE HANDLER OR UNSTACKED STAGE). The fuel turbopump can be reinstalled but cannot be replaced without affecting engine calibration.

NOTE

If the engine is in an unstacked stage, suitable handling equipment must be provided to support and lift the turbopump, which weighs 418 pounds.

a. Obtain the following:

(1) Rotating Sling G4063 (used when engine is in handler and if pump is to be rotated after removal)

(2) Turbopump Sling G4046 (used if engine is in handler)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257) from turbopump and mating connections on engine. Make sure turbopump, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

d. In the following steps remove closures only when turbopump connections are made on engine.

e. If engine is in engine handler, perform step f and proceed to step h. If engine is in an unstacked stage, proceed to step g.

f. Torque bolts that secure adapters to fuel turbopump to 25-30 in-lb and attach Rotating Sling G4063 or Turbopump Sling G4046 to adapters. (See figure 3-22.)

WARNING

Failure to provide adequate support and handling equipment for the turbopump can result in injury to personnel and damage to equipment.

g. Attach suitable equipment to lift and support weight of fuel turbopump (418 pounds).

h. Lift and position turbopump at thrust chamber attaching points.

i. For ease of installation install GG spark igniter cable G4 and seal at this time on GG combustor only. (Refer to paragraph 3-110.) If threads on igniter cable have been dry-film lubricated (threads have a blue-black cast), torque cable to 60-80 in-lb. If threads have not been lubricated, torque to 100-150 in-lb.

j. Install fitting, washers, and bolts that secure turbopump to thrust chamber. (See figure 3-21, detail B.) Torque bolts to 390-430 in-lb and safetywire.

WARNING

The following specifies primer (MIL-P-8585), which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

k. Apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, install fitting, spacers, bracket, and clevis using bolts and washers. (See figure 3-21, view A.) Torque bolts to 342-378 in-lb and safetywire.

l. Install pin, washers, and nut securing turbopump to thrust chamber. (See figure 3-21, detail C.) Torque nut to 100-140 in-lb. If pin does not aline with turbopump and thrust chamber fittings, loosen bolts that secure turbopump to thrust chamber, install pin, re-torque bolts as outlined in step j, and safety-wire.

m. Remove protective material, and weld the following lines: (Refer to section VI for welding requirements. Fabricate tubing extensions, as necessary.)

(1) Fuel turbine seal drain line

(2) Fuel turbopump primary seal drain line

(3) Fuel turbine seal purge line (TG10)

(4) Fuel turbopump primary seal purge line (PF7)

(5) Fuel pump balance piston pressure line (PF5) (on engines not incorporating MD150, MD280, or MD281 change)

(6) Fuel turbine inlet pressure line (TG1) (on engines not incorporating MD150 change but incorporating MD237 change)

(7) GG chamber pressure line (GG1 and GG1a) (on engines not incorporating MD150 or MD237 change)

(8) GG fuel injector and purge line (GF4) (on engines not incorporating MD150, MD280, or MD281 change)

(9) GG oxidizer injector and purge line (GO5) (on engines not incorporating MD150, MD280, or MD281 change)

(10) GG equalization line

(11) Fuel turbopump discharge pressure line (PF2) (on engines not incorporating MD150, MD280, or MD281 change)

n. Install GG spark igniter cables (paragraph 3-110).

o. Install seal, and connect STDV hose to fuel turbine manifold with bolts, washers, and brackets. Torque bolts to 285-315 in-lb.

p. Install seal between fuel high-pressure duct and turbopump fuel volute with bolts, washers, and brackets. Cross-torque bolts to 361-399 in-lb and safetywire.

q. Install seal and secure fuel bleed line and bracket to fuel bleed valve with bolts and washers. Torque bolts to 30-40 in-lb and safetywire.

r. Install seal, and secure control line and bracket to fuel bleed valve with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

s. Connect GG control valve as follows:

(1) Install seal, mainstage control manifold, and bracket on pneumatic inlet port with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

CAUTION

Incorrect orifice installation will affect engine calibration.

(2) Install orifices (flat side out), seals, oxidizer, and fuel feed lines on GG control valve with bolts and washers. Torque bolts to 48-52 in-lb and safetywire.

t. Install fuel turbine exhaust duct (paragraph 3-74).

u. Install oxidizer turbine bypass valve (paragraph 3-229).

v. Install fuel inlet duct (paragraph 3-58).

w. Connect the following electrical connectors (paragraph 3-31):

(1) P112

(2) P126

(3) P141 (On engines incorporating MD233 change, connector P141 has been removed.)

(4) P160

(5) P161 (On engines incorporating MD172 change, connector P161 is stowed. On engines incorporating MD185 change, connector P161 is removed.)

(6) P116

x. Reposition electrical cables and install clamps that were removed for turbopump access.

CAUTION

When moving the electrical interface support assembly, do not twist, kink, or stretch cables as damage to cables can result.

y. If engine is in handler, install 2 bolts securing electrical interface support assembly (GSE) to engine cable support frame. Torque bolts to 50-70 in-lb.

z. Refer to section IV for test requirements.

3-85. INSTALLING FUEL TURBOPUMP (STACKED SII STAGE). The fuel turbopump can be reinstalled but cannot be replaced without affecting engine calibration.

a. Obtain the following: (Items 3 through 8 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4071, shelf 3

(2) Hook 9024600 from Engine Components Installer G4071, shelf 1

(3) Hanger 9024543 from engine components installer set 9026251

(4) Pickup adapter 9024547 from engine components installer set 9026251

(5) Chain-hoist 9027095 from engine components installer set 9026251

(6) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(7) Universal joint S8 from engine components installer set 9026251

(8) Extension bar SX-24 from engine components installer set 9026251

(9) Torque wrench adapter T-5040045

(10) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(11) Components handling cart 9026253-11 from engine components installer set 9026251

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Install handler on fuel turbopump volute. Install handler with arrow pointing toward fuel turbopump attach point and index pin engaging hole in pump flange. Place lifting eye in fuel turbopump lifting position. Using torque wrench adapter, cross-torque handler attach bolts to 190-210 in-lb. Install closure RX20714 on handler.

NOTE

If the launch tower umbilical arm is to be used for transporting components to the stage, omit steps d through k; otherwise, omit steps l through n.

d. Install pickup adapter on handler.

e. Position hoist on track near stage access door, and install chain-hoist on hoist boom.

f. Move hoist through stage access door, lower hoist hook, and attach hoist hook to pickup adapter using a shackle.

g. Slowly raise turbopump (418 pounds) and transfer turbopump through stage access door.

h. Move turbopump to hanger and attach turbopump to hanger using pickup adapter swivel; secure with ball-lock pin.

i. Remove chain-hoist from hoist boom.

j. Install hook on hoist boom, as shown in figure 3-6, view A.

k. Connect hook on hoist boom to pickup adapter and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

l. Install hook on hoist boom, as shown in figure 3-6, view A.

m. Connect hook on hoist boom to handler lifting eye on fuel turbopump and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

n. Slowly raise turbopump (418 pounds) and transfer turbopump through stage access door.

o. Position hoist at track station 2 for engine positions 1 through 4, or track station 2 for engine position 5.

p. Remove closures (paragraph 3-257) as required during installation, to make inspections and connections.

q. Make sure turbopump, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

r. Using hoist, move fuel turbopump into position on engine.

s. For ease of installation install GG spark igniter cable G4 and seal on GG combustor only. (Refer to paragraph 3-110.) If threads on igniter cable have been dry-film lubricated (threads have a blue-black cast), torque cable to 60-80 in-lb. If threads have not been lubricated, torque to 100-150 in-lb.

t. Install fitting, washers, and bolts that secure turbopump to thrust chamber. (See figure 3-21, detail B.) Torque bolts to 390-430 in-lb and safetywire.

WARNING

The following specifies primer (MIL-P-8585), which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

u. Apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, install fitting, spacers, bracket, and clevis using bolts and washers. (See figure 3-21, detail A.) Torque bolts to 342-378 in-lb and safetywire.

v. Install pin, washer, and nut securing turbopump to thrust chamber. (See figure 3-21, detail C.) Torque nut to 100-140 in-lb. If pin does not aline with turbopump and thrust chamber fittings, loosen bolts that secure turbopump to thrust chamber, install pin, retorque bolts to 390-430 in-lb, and safetywire.

w. Weld the following lines: (Refer to section VI for welding requirements. Fabricate tubing extension, as necessary.)

(1) Fuel turbine seal drain line

(2) Fuel turbopump primary seal drain line

(3) Fuel turbine seal purge line (TG10)

(4) Fuel turbopump primary seal purge line (PF7)

(5) Manifold seal bleed line (capped)

(6) GG equalization line

x. Install GG spark igniter cables (paragraph 3-110).

y. Install seal, and connect STDV hose to fuel turbine manifold with bolts, washers, and brackets. Torque bolts to 285-315 in-lb.

z. Install seal between fuel high-pressure duct and turbopump fuel volute with bolts, washers, and brackets. Cross-torque bolts to 361-399 in-lb and safetywire.

aa. Install seal and secure fuel bleed line and bracket to fuel bleed valve with bolts and washers. Torque bolts to 30-40 in-lb and safetywire.

ab. Install seal and secure control line and bracket to fuel bleed valve with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

ac. Connect GG control valve as follows:

(1) Install seal, mainstage control manifold, and bracket on pneumatic inlet port with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

CAUTION

Incorrect orifice installation will affect engine calibration.

(2) Install orifices (flat side out), seals, oxidizer, and fuel feed lines on GG control valve with bolts and washers. Torque bolts to 48-52 in-lb and safetywire.

ad. Install fuel turbine exhaust duct (paragraph 3-75).

ae. Install oxidizer turbine bypass valve (paragraph 3-229).

af. Install fuel inlet duct (paragraph 3-65).

ag. Connect the following electrical connectors (paragraph 3-31):

(1) P112

(2) P126

(3) P141 (On engines incorporating MD233 change, connector P141 has been removed.)

(4) P160

(5) P161 (On engines incorporating MD172 change, connector P161 is stowed. On engines incorporating MD185 change, connector P161 is removed.)

(6) P116

ah. Reposition electrical cables and install clamps that were removed for turbopump access.

ai. Refer to section IV for test requirements.

3-86. INSTALLING FUEL TURBOPUMP (STACKED SIVB STAGE). The fuel turbopump can be reinstalled but cannot be replaced without affecting engine calibration. Engine Components Installer G4072MD2 must be used when performing this task.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following:

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4072, shelf 3

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

(3) Pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Adapter 9026997 from engine components installer set 9026252

(6) Chain-hoist 9027095 from engine components installer set 9026252

(7) Component handling cart 9026253-11 from engine components installer set 9026252

(8) Universal joint S8 from engine components installer set 9026252

(9) Extension bar SX-24 from engine components installer set 9026252

(10) Torque wrench adapter T-5040045

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove closures (paragraph 3-257) as required during installation to make inspections and connections.

d. Make sure turbopump, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

e. Install handler and adapter on fuel turbopump volute as follows:

(1) Install handler with arrow pointing toward fuel turbopump attach point and index pin engaging hole in pump flange. Place lifting eye in fuel turbopump lifting position.

(2) Using torque wrench adapter, cross-torque handler attach bolts to 190-210 in-lb.

(3) Remove screws that attach closure to handler.

(4) Place adapter on closure, and install closure and adapter on handler. Cross-torque bolts to 50-70 in-lb.

(5) Make sure lifting adapter on turbopump adapter is directly above centerline chain fuel turbopump position. Remove quick-disconnect pin and rotate adapter, as required.

f. Install chain-hoist on hoist and secure with ball-lock pin.

g. Connect chain-hoist chain fitting to lifting adapter, and torque internal wrenching bolt (on chain fitting) to 12-15 in-lb.

NOTE

The fuel turbopump weighs 418 pounds.

h. Using chain-hoist and hoist, raise fuel turbopump from component handling cart.

CAUTION

The fuel turbopump must be restrained due the the limited access, to prevent damage to the fuel turbopump and stage.

i. Using hoist, move fuel turbopump into stage. Manually restrain movement of fuel turbopump when moving it through stage access door.

j. Make sure pickup adapter is attached to hanger.

k. Using hoist, move fuel turbopump to hanger and aline handler lifting eye with pickup adapter.

l. Secure fuel turbopump to hanger with ball-lock pin on pickup adapter.

m. Remove hoist and chain-hoist. Install chain-hoist hook on chain-hoist, and torque internal wrenching bolt to 12-15 in-lb.

n. Disassemble elevated track, and reassemble lower track. (Refer to section V.)

o. Install hook on hoist. (See figure 3-6, view A.)

p. Position hoist, connect hook to pickup adapter, and secure with ball-lock pin.

CAUTION

Raising the hoist boom above the indicated maximum height can damage the equipment.

q. Raise hoist and remove fuel turbopump from hanger. Do not raise hoist above indicated maximum height. Adjust boom turnbuckle to obtain additional hoist height.

r. Using hoist, move fuel turbopump (figure 3-22) into position on engine.

s. For ease of installation install GG spark igniter cable G4 and seal at this time on GG combustor only. (Refer to paragraph 3-110.) If threads on igniter cable have been dry-film lubricated (threads have a blue-black cast), torque cable to 60-80 in-lb. If threads have not been lubricated, torque to 100-150 in-lb.

t. Install fitting, washers, and bolts that secure turbopump to thrust chamber (figure 3-21, detail B). Torque bolts to 390-430 in-lb and safetywire.

WARNING

The following specifies primer (MIL-P-8585), which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

u. Apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, install fitting, spacers, bracket, and clevis using bolts and washers. (See figure 3-21, view A) Torque bolts to 342-378 in-lb and safetywire.

v. Install pin, washer, and nut securing turbopump to thrust chamber. (See figure 3-21, detail C.) Torque nut to 100-140 in-lb. If pin does not aline with turbopump and thrust chamber fittings, loosen bolts that secure turbopump to thrust chamber, install pin, retorque bolts as outlined in step t, and safetywire.

w. Weld the following lines: (Refer to section VI for tube welding requirements. Fabricate tubing extension as necessary.)

(1) Fuel turbine seal drain line

(2) Fuel turbopump primary seal drain line

(3) Fuel turbine seal purge line (TG10)

(4) Fuel turbopump primary seal purge line (PF7)

(5) Manifold seal bleed (capped)

(6) GG equalization line

x. Install GG spark igniter cable (paragraph 3-110).

y. Install seal and connect STDV hose to fuel turbine manifold with bolts and washers and brackets. Torque bolts to 285-315 in-lb.

z. Install seal between fuel high-pressure duct and turbopump fuel volute with bolts, washers, and brackets. Cross-torque bolts to 361-399 in-lb and safetywire.

aa. Install seal and secure fuel bleed line and bracket to fuel bleed valve with bolts and washers. Torque bolts to 30-40 in-lb and safetywire.

ab. Install seal and secure control line and bracket to fuel bleed valve with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

ac. Reposition electrical cables and install clamps that were removed for turbopump access.

ad. Connect GG control valve as follows:

(1) Install seal, mainstage control manifold, and bracket on pneumatic inlet port with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

CAUTION

Incorrect orifice installation will affect engine calibration.

(2) Install orifices (flat side out), seals, oxidizer, and fuel feed lines on GG control valve with bolts and washers. Torque bolts to 48-52 in-lb and safetywire.

ae. Remove handler and adapter, and install fuel inlet duct (paragraph 3-66).

af. Disassemble and reassemble track (section V) for installation of fuel turbine exhaust duct.

ag. Install fuel turbine exhaust duct (paragraph 3-76).

ah. Install OTVB (paragraph 3-229).

ai. Connect the following electrical connectors (paragraph 3-31):

(1) P112

(2) P126

(3) P141 (On engines incorporating MD233 change, connector P141 has been removed.)

(4) P160

(5) P161 (On engines incorporating MD172 change, connector P161 is stowed. On engines incorporating MD185 change, connector P161 is removed.)

(6) P116

aj. Refer to section IV for test requirements.

3-87. <u>FUEL TURBOPUMP DISCHARGE TEMPERATURE TRANSDUCER.</u>

3-88. REMOVING FUEL TURBOPUMP DISCHARGE TEMPERATURE TRANSDUCER. (See figure 3-23.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove support clamps as necessary (note position and location for reinstallation), and disconnect electrical connector P124 (8) (paragraph 3-30).

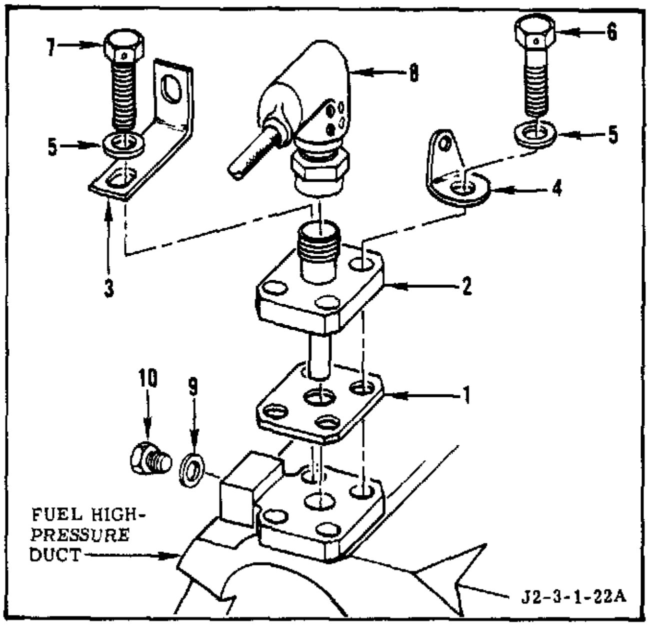
c. Remove bolts (7, 6), washers (5), lug (4), bracket (3), temperature transducer (2), and seal (1). Install clean protective closure (paragraph 3-258) on temperature transducer port of fuel high-pressure duct.

3-89. INSTALLING FUEL TURBOPUMP DISCHARGE TEMPERATURE TRANSDUCER. (See figure 3-23.)

a. If transducer is being replaced, verify that temperature transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closure (paragraph 3-257) from fuel turbopump discharge temperature transducer port on fuel high-pressure duct.



Index Number	Description
1	Seal
2	Temperature transducer
3	Bracket
4	Lug
5	Washer
6	Bolt RD111-1011-0414
7	Bolt RD111-1009-3411
8	Electrical connector P124
9	Gasket
10	Plug

Figure 3-23. Fuel Turbopump Discharge Temperature Transducer

c. Make sure sealing surfaces of transducer and mating port are clean and free of damage, and threads in parent metal and/or threaded inserts are free of damage and installed correctly (section I).

d. Make sure transducer is clean, free of damage, and OK to install.

e. Place seal (1) over stem of temperature transucer (2); insert and position transducer on transducer boss to aline transducer connector key with electrical connector (8) P124 keyway; then install bracket (3), lug (4), washer (5), and bolts (6, 7). Cross-torque bolts (6, 7) to 48-53 in-lb and safetywire.

f. Connect electrical connector P124 (8) (paragraph 3-31).

g. Refer to section IV for test requirements.

3-90. FUEL TURBOPUMP SPEED TRANSDUCER.

3-91. REMOVING FUEL TURBOPUMP SPEED TRANSDUCER. (See figure 3-24.)

CAUTION

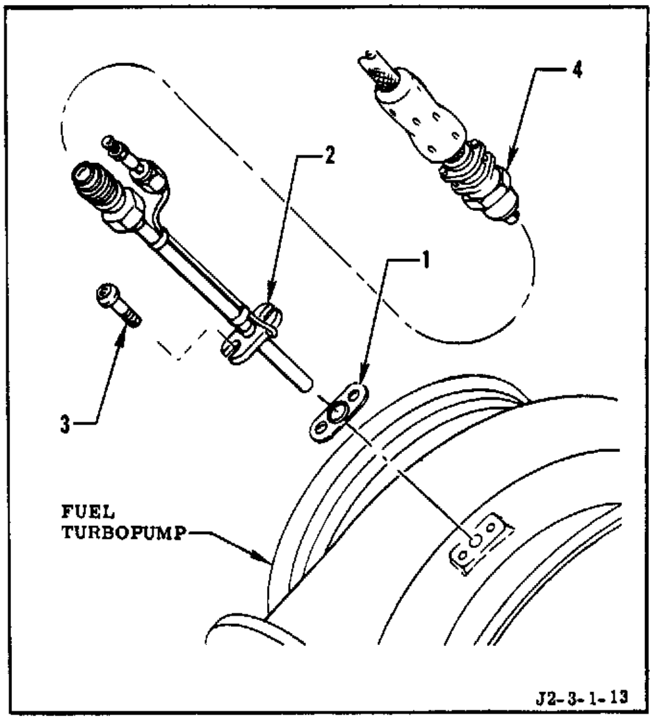
Attempting to remove the transducer without sufficient space between the turbopump volute and the turbine manifold could damage the transducer.

a. Measure dimension A shown in figure 3-24A. If 1.00 inch or greater, proceed to step aA. If dimension A is less than 1.00 inch (nominal dimension for B), do not attempt to remove transducer. Contact Engine Contractor field engineering representative for evaluation and disposition.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove support clamps as necessary (note position and location for reinstallation), and disconnect electrical connector P112 (4) (paragraph 3-30).

c. Remove bolts (3), speed transducer (2), and seal (1). Install clean protective closure (paragraph 3-258) on speed transducer port of fuel turbopump.



Index Number	Description
1	Seal
2	Speed transducer
3	Bolt
4	Electrical connector P112

Figure 3-24. Fuel Turbopump Speed Transducer

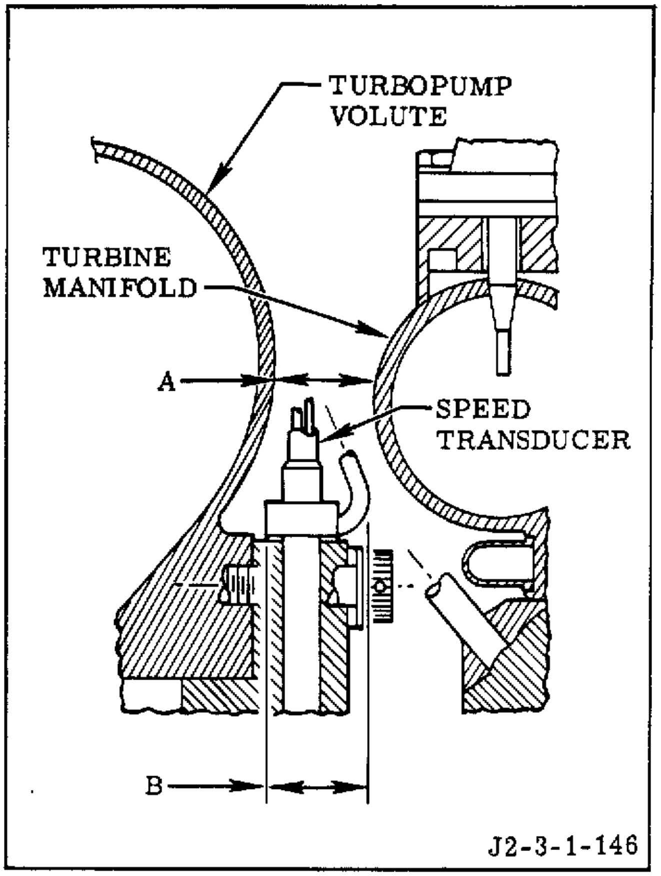


Figure 3-24A. Installation of Fuel Turbopump Speed Transducer

3-92. INSTALLING FUEL TURBOPUMP SPEED TRANSDUCER. (See figure 3-24.)

a. If transducer is being replaced, verify that speed transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closure (paragraph 3-257) from speed transducer port on fuel turbopump.

c. Make sure sealing surface of transducer and mating port are clean and free of damage, and threads in parent metal and/or threaded inserts are free of damage and installed correctly (section I).

d. Make sure transducer is clean, free of damage, and OK to install.

e. Place seal (1) over stem of speed transducer (2), insert and position seal and transducer in boss to aline transducer connector key with electrical connector P112 (4) keyway, and install bolts (3). Torque bolts (3) to 65-75 in-lb and safetywire.

f. Connect electrical connector P112 (4) (paragraph 3-31).

g. Refer to section IV for test requirements.

3-93. GAS GENERATOR CONTROL VALVE.

3-94. REMOVING GAS GENERATOR CONTROL VALVE. (See figure 3-25.)

a. Obtain torque wrench adapter kit T-5038118 (or equivalent).

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove support clamps as necessary to remove GG control valve. Note position of clamps for reinstallation.

c. Disconnect electrical connector (paragraph 3-30) P116.

d. Remove bolts and washers that secure bracket and mainstage control manifold to GG control valve and remove bracket and seal. Protect ports and sealing surfaces.

e. Remove bolts and washers that secure mainstage control manifold to fast-shutdown valve and remove seal. Protect ports and sealing surfaces.

f. Cut GG control valve equalization line. (Refer to section VI for tube cutting requirements.) Protect open ends of line.

g. Remove equalization line adapter and seal from GG control valve. Install clean protective closures (paragraph 3-258) on equalization line and adapter port.

h. Remove bolts and washers that secure fuel feed line to fuel inlet flange, and remove seal and orifice. Retain orifice for reinstallation. Protect open port and sealing surfaces.

i. Remove bolts and washers that secure oxidizer feed line to oxidizer inlet flange, and remove seal and orifice. Retain orifice for reinstallation. Protect open port and sealing surfaces.

j. Remove retaining screw and washer that secure oxidizer body and bellows to fuel housing.

k. Using torque wrench adapter kit where necessary, remove nuts and washers that secure fuel housing to injector, and carefully separate fuel housing from injector and oxidizer body and bellows. Remove seal located between fuel housing and injector, and packing located between fuel housing and oxidizer body and bellows.

l. Install clean protective closures (paragraph 3-258) on fuel housing, injector, and on oxidizer body and bellows.

m. Using torque wrench adapter kit where necessary, remove bolts and washers that secure oxidizer body and bellows to injector. Remove oxidizer body and bellows, and the seal located between oxidizer body and bellows and injector. Install clean protective closures (paragraph 3-258) on injector and on oxidizer body and bellows mating ports.

n. Remove all protective material from GG control valve and engine ports, install clean protective closures (paragraph 3-258).

o. *If GG control valve is to be reinstalled*, identify oxidizer body and bellows by marking GG control valve serial number on closure. Seal fuel housing and cover in a clean plastic bag.

p. If control valve is not to be reinstalled or if control valve will be packaged for shipping, remove closure from bellows end of oxidizer body and bellows and carefully install seal and oxidizer body and bellows in control valve; then secure with retaining washer and screws. *Torque screw to 6-8 in-lb.*

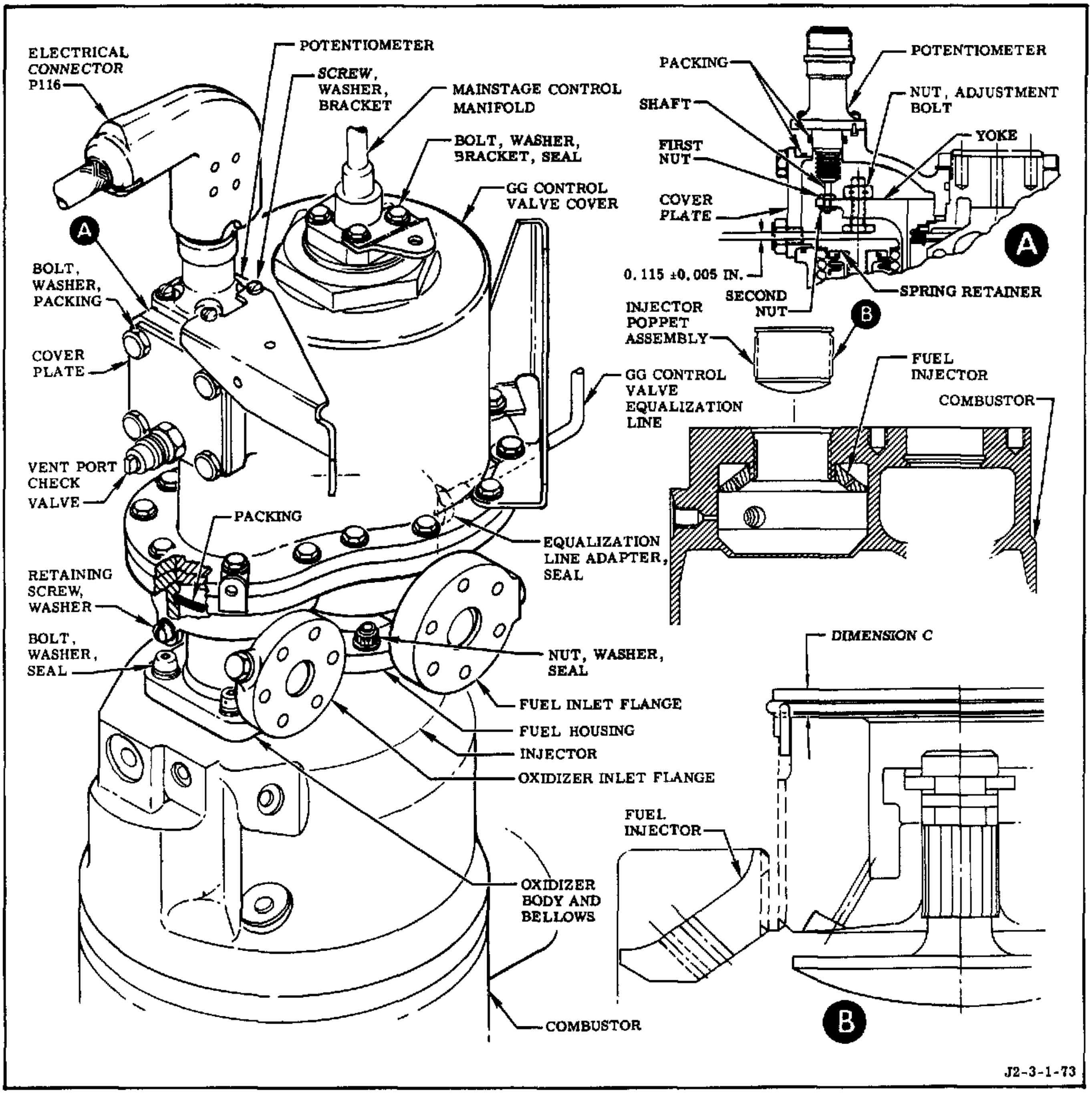


Figure 3-25. Gas Generator Control Valve, Potentiometer, and Injector Poppet

3-95. INSTALLING GAS GENERATOR CONTROL VALVE. (See figure 3-25.)

a. Obtain the following:

(1) Torque wrench adapter kit T-5038118 (or equivalent).

(2) Ohmmeter capable of measuring from zero to 2 ohms accurately within 0.3 ohms.

(3) Resistance bridge capable of measuring from zero to 3,000 ohms accurately within 3 ohms.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. If oxidizer body and bellows are installed in control valve, remove retaining screw and washer and remove oxidizer body and bellows from control valve. Install clean protective closure (paragraph 3-258) on oxidizer body and bellows and on open port on control valve.

c. Remove protective closures (paragraph 3-257) from, and protect the following ports and mating surfaces: (Do not remove protective closures from GG control valve at this time.)

(1) Mainstage control manifold to GG control valve

(2) Fuel line to fuel inlet flange

(3) Oxidizer line to oxidizer inlet flange

(4) Mainstage control manifold to fast-shutdown valve

d. Remove closure (paragraph 3-257) from injector oxidizer flange. Make sure flange, mating connection, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

e. Remove closure (paragraph 3-257) from oxidizer body and bellows flange that mates to injector, and make sure body and bellows are clean, free of damage, and OK to install.

f. Install seal and oxidizer body and bellows on injector and secure with bolts and washers. Using torque wrench adapter kit where necessary, torque bolts to 95 ±10 in-lb and safetywire.

g. Remove and discard packing from oxidizer body and bellows mating port.

h. Lubricate (Method J, section I) packing with lubricant grease RB0140-012 (Rocketdyne) and install in oxidizer body and bellows mating port.

i. Remove closures (paragraph 3-257) from fuel housing and injector.

j. Make sure GG control valve fuel housing, injector mating surfaces, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

k. Make sure fuel housing and GG control valve cover is clean, free of damage, and OK to install.

l. Remove protective closure (paragraph 3-257) from oxidizer body and bellows, install seal on injector fuel port, and carefully install fuel housing and cover. Secure fuel housing to injector with washers and nuts. Using torque wrench adapter kit where necessary, torque nuts to 60 ±5 in-lb.

m. Secure oxidizer body and bellows to fuel housing with retaining washer and screw. Torque screw to 6-8 in-lb and safetywire.

n. Remove bolts and washers that secure cover plate on fuel lead adjustment port. Remove cover plate and packing; discard packing.

o. Check fuel lead adjustment by measuring gap between spring retainer and adjustment bolt. If gap is 0.110 to 0.120 inch, proceed to step p; if gap is not 0.110 to 0.120 inch, proceed as follows:

CAUTION

Permitting pieces of lockwire to fall into the GG control valve cavity can result in damage to the valve.

(1) Remove lockwire from nuts that secure potentiometer shaft to yoke, and remove second nut. Do not let lockwire or nut fall into valve.

(2) Remove screws and washers that secure potentiometer to GG control valve. Remove bracket, potentiometer, and packing; discard packing.

(3) Remove lockwire from nut and adjustment bolt. Do not let lockwire fall into valve.

(4) Adjust bolt until gap between spring retainer and adjustment bolt is 0.110 to 0.120 inch.

(5) Torque nut to 160-190 in-lb. Recheck gap to make sure gap is 0.110 to 0.120 inch.

(6) Safetywire nut and adjustment bolt. Make sure pieces of lockwire do not fall into valve.

(7) Make sure only first nut is installed on potentiometer shaft and is turned on to full length of shaft threads to permit maximum extension of shaft through yoke.

(8) Lubricate (Method J, section I) packing for potentiometer with lubricant grease RB0140-012 (Rocketdyne).

(9) Install and secure packing, potentiometer, and bracket with washers (washers between potentiometer and bracket) and screws. Torque screws to 6-8 in-lb and safetywire.

(10) Connect ohmmeter leads to pins D and E of potentiometer.

(11) Connect resistance bridge leads to pins A and B of potentiometer.

(12) Adjust first nut on potentiometer shaft until ohmmeter connected to pins D and E indicates 0.5 (+0, -0.5) ohm. Do not adjust nut beyond initial point of continuity across pins D and E.

(13) Observe resistance indicated on resistance bridge (connected to pins A and B).

(14) Continue to adjust first nut on potentiometer shaft until resistance indicated in substep 13 is reduced by 270 ±10 ohms. Make sure resistance across connector pins D and E still indicates 0.5 (+0, -0.5) ohm.

(15) Install second nut on potentiometer shaft, torque to 51.5 to 77 in-oz, and safetywire. Make sure resistance indication on resistance bridge did not change by more than 10 ohms during installation of nut, torquing, and safetywiring, and make sure pieces of lockwire do not fall into valve.

p. Lubricate (Method J, section I) packing for cover plate with lubricant grease RB0140-012 (Rocketdyne).

q. Install and secure packing and cover plate with bolts and washers. Torque bolts to 72-80 in-lb and safetywire.

r. Verify GG control valve seals by pulling a vacuum on valve. Seals are satisfactory if 10 millimeters (absolute pressure) can be obtained. Replace seals installed in step h, step o (substep 9), and/or step q, and repeat test if requirement is not met. Observe the following:

(1) Remove vent port check valve and apply vacuum to vent port check valve port. Do not exceed 65 in-lb torque to vent port check valve port when installing test fittings.

(2) Make sure equalization tube port is sealed with a plug and packing. Torque plug to 10-16 in-lb.

s. Shut down vacuum pump; disconnect pump, gage, and fittings from cover plate; and install vent port check valve (paragraph 3-309) on cover plate.

t. Remove protective material from mainstage control manifold and mating ports on GG control valve and fast-shutdown valve.

u. Install and secure fuel seal and mainstage control manifold on fast-shutdown valve with bolts and washers. Cross-torque bolts to 41-45 in-lb and safetywire.

v. Install and secure seal, mainstage control manifold, and bracket on GG control valve with bolts and washers. Cross-torque bolts to 41-45 in-lb and safetywire.

w. Remove protective material from GG oxidizer line and oxidizer inlet flange.

x. Install and secure orifice (same orifice that was removed, with flat side out), seal, and GG oxidizer line on oxidizer inlet flange with bolts and washers. Cross-torque bolts to 48-52 in-lb and safetywire.

y. Remove protective material from GG fuel line and fuel inlet flange.

z. Install and secure orifice (same orifice that was removed, with flat side out), seal, and GG fuel line on fuel inlet flange with bolts and washers. Cross-torque bolts to 48-52 in-lb and safetywire.

aa. Remove plug from equalization line port, and install seal and adapter. Torque adapter to 52-58 in-lb.

ab. Remove protective material, and weld GG control valve equalization line. (Refer to section VI for tube welding requirements.)

ac. Connect electrical connector (paragraph 3-31) P116.

ad. Reinstall all support clamps, and torque screws to 24-30 in-lb.

ae. Refer to section IV for test requirements.

3-96. <u>GAS GENERATOR CONTROL VALVE POTENTIOMETER.</u>

3-97. REMOVING GAS GENERATOR CONTROL VALVE POTENTIOMETER. The GG control valve potentiometer (figure 3-25) may be removed and replaced without affecting engine calibration.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (paragraph 3-30) P116.

c. Remove bolts and washers that secure cover plate to GG control valve. Remove cover and seal. Discard seal.

CAUTION

> Permitting pieces of lockwire to fall into the GG control valve cavity can result in damage to the valve.

d. Remove lockwire from nuts that secure potentiometer shaft to yoke and remove 2nd nut. Do not let lockwire fall into valve.

e. Remove screws that secure potentiometer to GG control valve. Remove bracket, washers, potentiometer, and packing. Discard packing.

f. Install clean protective closures (paragraph 3-258) on all open ports.

3-98. INSTALLING GAS GENERATOR CONTROL VALVE POTENTIOMETER. The GG control valve potentiometer (figure 3-25) may be reinstalled or replaced without affecting engine calibration.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from ports on GG control valve.

c. Check fuel lead adjustment by measuring gap between oxidizer housing spring retainer and adjustment bolt. If gap is 0.110 to 0.120 inch, proceed to step d; if gap is not 0.110 to 0.120 inch, proceed as follows:

CAUTION

> Permitting pieces of lockwire to fall into the GG control valve cavity can result in damage to the valve.

(1) Remove lockwire from nut and adjustment bolt. Do not let lockwire fall into valve cavity.

(2) Adjust bolt to obtain a 0.110 to 0.120 inch gap between oxidizer housing spring retainer and adjustment bolt.

(3) Torque nut to 160-190 in-lb. Recheck gap to make sure a 0.110 to 0.120 inch gap exists.

(4) Safetywire nut and adjustment bolt. Make sure pieces of lockwire do not fall into valve cavity.

d. Make sure GG control valve potentiometer is clean, free of damage, and OK to install.

e. Make sure threads in parent metal and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

f. Make sure only first nut is installed on potentiometer shaft, and is turned on to full length of shaft threads to permit maximum extension of shaft through yoke.

g. Lubricate (Method J, section I) packing for potentiometer with lubricant grease RB0140-012 (Rocketdyne).

h. Install and secure packing, potentiometer, and bracket with washers (washers between potentiometer and bracket) and screws. Torque screws to 6-8 in-lb and safetywire.

i. Using an ohmmeter capable of measuring a range of zero to 2 ohms with ±15 percent accuracy, connect ohmmeter leads to pins D and E of GG control valve potentiometer.

j. Using a resistance bridge capable of measuring a range of zero to 3,000 ohms with an accuracy of ±0.1 percent, connect resistance bridge leads to pins A and B of GG control valve potentiometer.

k. Adjust first nut on potentiometer shaft until ohmmeter connected to pins D and E indicates 0.5 (+0, -0.5) ohm. Do not adjust nut beyond point of initial continuity across pins D and E.

l. Oberve resistance indicated on resistance bridge (connected to pins A and B).

m. Continue to adjust first nut on potentiometer shaft until resistance indicated in step k is reduced by 270 ±10 ohms. Make sure resistance across connector pins D and E still indicates 0.5 (+0, -0.5) ohm.

n. Install 2nd nut on potentiometer shaft, torque nut to 51.5 to 77 in-oz, and safetywire. Make sure resistance indication on resistance bridge did not change by more than 10 ohms during installation of nut, torquing, and safetywiring, and make sure pieces of lockwire do not fall into valve cavity.

o. Lubricate (Method J, section I) packing for cover with lubricant grease RB0140-012 (Rocketdyne).

p. Install and secure packing and cover plate with bolts and washers. Torque bolts to 72-80 in-lb and safetywire.

q. Connect electrical connector (paragraph 3-31) P116.

r. Refer to section IV for test requirements.

3-99. GAS GENERATOR FUEL LINE.

3-100. REMOVING GAS GENERATOR FUEL LINE. (See figure 3-13.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove bolts and washers that secure GG fuel line to GG control valve; remove seal and orifice, and protect open ports and sealing surfaces. Retain orifice for reinstallation.

c. Remove bolts and washers that secure fuel bleed valve to GG fuel line; remove seal, and protect open ports and sealing surfaces.

d. Remove bolts and washers that secure GG fuel line to fuel high-pressure duct; remove seal, and protect open ports and sealing surfaces.

3-101. INSTALLING GAS GENERATOR FUEL LINE. (See figure 3-13.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure mating connections on GG fuel line, fuel high-pressure duct, fuel bleed valve, and GG control valve are clean and free of damage, and threads in parent metal and/or threaded inserts are free of damage and installed correctly (section I). Protect open ports and sealing surfaces.

c. Make sure GG fuel line is clean, free of damage, and OK to install.

d. Remove protective material from mating flanges of GG fuel line and fuel high-pressure duct, and install GG fuel line on fuel high-pressure duct with seal, bolts, and washers. Tighten bolts fingertight.

e. Remove protective material from mating flanges of fuel bleed valve and GG fuel line, and install fuel bleed valve on GG fuel line with seal, bolts, and washers. Tighten bolts fingertight.

CAUTION

Incorrect orifice installation will affect engine calibration.

f. Remove protective material from mating flanges of GG fuel line and GG control valve, and install orifice (with flat side out), seal, and GG fuel line on GG control valve with bolts and washers. Tighten bolts fingertight.

g. Cross-torque bolts that secure GG fuel line to fuel high-pressure duct to 143-157 in-lb and safetywire.

h. Cross-torque bolts that secure fuel bleed valve to GG fuel line to 143-157 in-lb and safetywire.

i. Cross-torque bolts that secure GG fuel line to GG control valve to 48-52 in-lb and safetywire.

3-102. GAS GENERATOR OXIDIZER INJECTOR POPPET.

3-103. REMOVING GAS GENERATOR OXIDIZER INJECTOR POPPET. The GG oxidizer injector poppet assembly (figure 3-25) may be reinstalled but not replaced without affecting engine calibration.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove GG control valve (paragraph 3-94).

c. Measure and record dimension C (figure 3-25) for reinstallation. (Measurement must be accurate to 0.001 inch.)

d. Remove remaining spring by pulling spring away from groove in combustor body and raising spring upward to remove tang from injector groove. If mechanical leverage is required, pad edge of combustor with soft material to prevent damage to corner of combustor inlet.

e. Using a spanner wrench in the 3/16-inch holes, unscrew oxidizer injector poppet assembly from combustor.

f. Install clean protective closures (paragraph 3-258).

3-104. INSTALL GAS GENERATOR OXIDIZER INJECTOR POPPET. The GG oxidizer injector poppet assembly (figure 3-25) must be reinstalled.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure GG injector poppet, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

c. Clean old lubricant from combustor threads and poppet using a clean, lint-free cloth moistened with trichloroethylene (MIL-T-27602).

d. Lubricate poppet by filling 2nd through 6th threads (numbered from poppet end of assembly) with sealant and antiseize compound RB0140-009 (Rocketdyne).

e. Using a spanner wrench in the 3/16-inch holes, install injector poppet assembly in combustor body until assembly bottoms.

f. Using a clean, dry nylon cloth No. 7815 (Victor Gloves, Inc) clean excess sealant from retainer ring groove and remove any sealant on top of poppet assembly or extruding from locking slots.

g. Back out poppet assembly until bottom of locking slots can be cleaned; one to 2 threads will show.

h. Using a clean, dry nylon cloth No. 7815 (Victor Gloves, Inc), wipe sealant from thread relief, locking slots, and from above threaded portion of poppet assembly. Do not attempt to clean sealant from poppet threads.

i. Screw poppet assembly into combustor body until assembly seats on housing shoulder.

j. Back out poppet assembly until dimension C (recorded at disassembly) is reached; then turn poppet assembly until nearest slot in poppet assembly is alined with slot in injector body.

k. Using a clean, dry nylon cloth No. 7815 (Victor Gloves, Inc), remove any excess sealant, and make sure instrumentation port GO5 is open and free of sealant.

l. Install retainer ring by inserting tang in locking slot of poppet assembly and combustor body and compressing ring into circumferential groove of combustor body. Pad corner of combustor inlet for protection, if necessary.

m. Remeasure dimension C to make sure poppet did not move during cleaning and installation of compression ring. Remove retainer ring and readjust poppet assembly, if necessary.

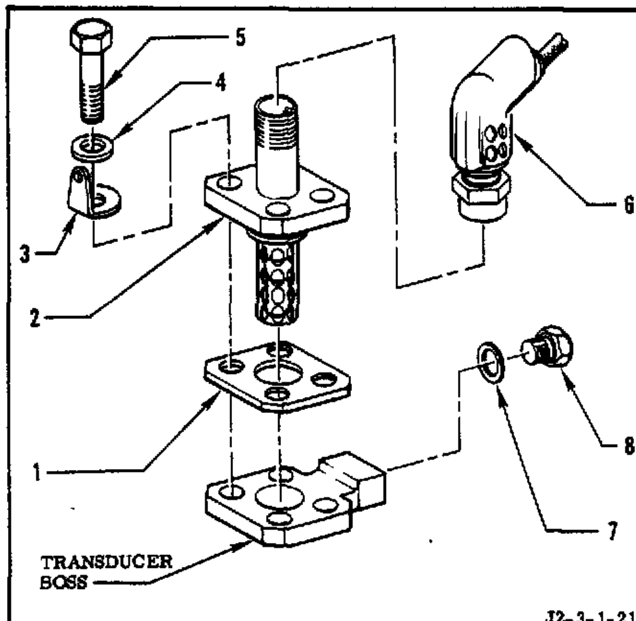
n. Install GG control valve (paragraph 3-95).

o. Refer to section IV for test requirements.

3-105. GAS GENERATOR OVERTEMPERATURE TRANSDUCER.

3-106. REMOVING GAS GENERATOR OVERTEMPERATURE TRANSDUCER. (See figure 3-26.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.



Index Number	Description
1	Seal
2	Temperature transducer
3	Lug
4	Washer
5	Bolt
6	Electrical connector P160
7	Gasket
8	Plug

Figure 3-26. Gas Generator Overtemperature Transducer

b. If removal is being performed on test stand, disconnect electrical connector P160 (6) (paragraph 3-30).

NOTE

The GG overtemperature transducer is for static test only and is not connected to the engine electrical harness.

c. Remove bolts (5), washers (4), lug (3), temperature transducer (2), and seal (1). If transducer and seal do not loosen easily from boss, use crowfoot or open-end wrench on transducer flange and rotate just enough to loosen seal and transducer. Install clean protective closure (paragraph 3-258).

3-107. INSTALLING GAS GENERATOR OVERTEMPERATURE TRANSDUCER. (See figure 3-26.)

a. Obtain mounting pad polishing tool DJ-1.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closure from GG overtemperature transducer boss on fuel turbopump. Make sure boss sealing surface is free of nicks, scratches, deposits, and other imperfections that would impair the sealing function, and that sealing surface is flat within 0.002 inch.

d. If sealing surface is damaged, refinish surface, using an electric or air-driven motor, mounting pad polishing tool DJ-1, and 600-grit abrasive paper.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

e. After refinishing surface, remove seal vent port plug and blow grinding particles from sealing surface and from seal vent port with low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A).

f. Make sure threads in parent metal and/or threaded inserts in transducer boss are free of damage and installed correctly (section I).

g. Make sure vent port plug is clean, free of damage, and OK to install.

h. Install seal and plug in seal vent port. Torque plug to 70 ±5 in-lb.

i. Wipe transducer boss sealing surface with a clean, lint-free cloth, and make sure GG overtemperature transducer is clean, free of damage, and OK to install.

j. Install seal (1) and temperature transducer (2) on GG overtemperature boss of fuel turbopump with lug (3), washers (4), and bolts (5). Torque bolts to 80 ±5 in-lb and safetywire.

k. If installation is being made on test stand, connect electrical connector P160 (6) (paragraph 3-31).

NOTE

The GG overtemperature transducer is for static test only and is not connected to the engine electrical harness.

3-107A. <u>GAS GENERATOR OXIDIZER PURGE CHECK VALVE.</u>

3-107B. REMOVING GAS GENERATOR OXIDIZER PURGE CHECK VALVE. (See figure 3-26A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Cut oxidizer dome and GG oxidizer cavity purge manifold between check valve and tee. (Refer to section VI for tube cutting requirements.) Protect open lines.

c. Remove hardware that secures oxidizer dome and GG oxidizer cavity purge manifold to GG LOX purge tube.

d. Remove cut portion of purge manifold with check valve and seal. Install clean protective closures (paragraph 3-258) on opened ports.

e. Remove plug and gasket from removed portion of purge manifold. Install a clean protective closure (paragraph 3-258) in open port of check valve.

3-107C. INSTALLING GAS GENERATOR OXIDIZER PURGE CHECK VALVE. (See figure 3-26A.)

a. If check valve is being replaced, verify that purge and seal drain check valve preinstallation tests in R-3825-3, Volume II have been performed.

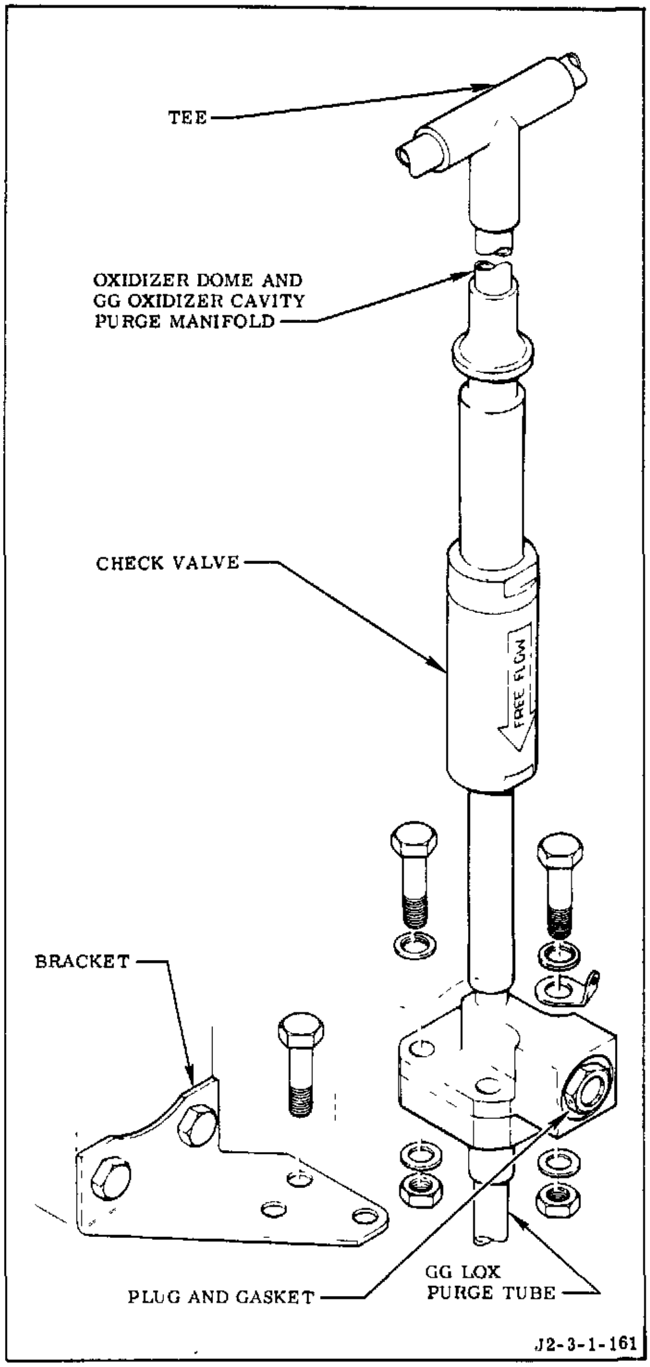


Figure 3-26A: Gas Generator Oxidizer Purge Check Valve

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Fit replacement portion of purge manifold to engine. (Refer to section VI for fit requirements for tubes to be welded.)

c. Remove protective closures (paragraph 3-257) from purge manifold and GG LOX purge tube. Make sure purge manifold and GG LOX purge tube are clean and free of damage.

d. Install plug and gasket in flange of purge manifold. Torque plug to 22-28 in-lb.

e. Install seal between flanges of purge manifold and GG LOX purge tube and install hardware that secures bracket and purge manifold to GG LOX purge tube. Torque bolts to 19-21 in-lb.

f. Safetywire plug.

g. Weld (section VI) oxidizer dome and GG oxidizer cavity purge manifold.

h. Refer to section IV for test requirements.

3-108. GAS GENERATOR SPARK IGNITER CABLES.

3-109. REMOVING GAS GENERATOR SPARK IGNITER CABLES. The GG spark igniter cable (figure 3-27) G3 may be removed, reinstalled, or replaced (bend radius of the cable must be kept greater than 4 inches during removal and installation). The GG spark igniter cable G4 may be removed and replaced, but a G4 cable must never be reinstalled on any engine. Due to the sharp bend radius of the G4 cable and the turning and flexing of the cable during installation and removal, the cable bellows may fatigue and crack with repeated installations.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Measure pressure in spark igniter cables as outlined in R-3825-1B.

c. Depressurize spark igniter cables by backing off pressurizing valve swivel nut (using crowfoot wrench 9019552 from tool kit 9025425-11) 1/2 to 1 turn and depressing valve cores.

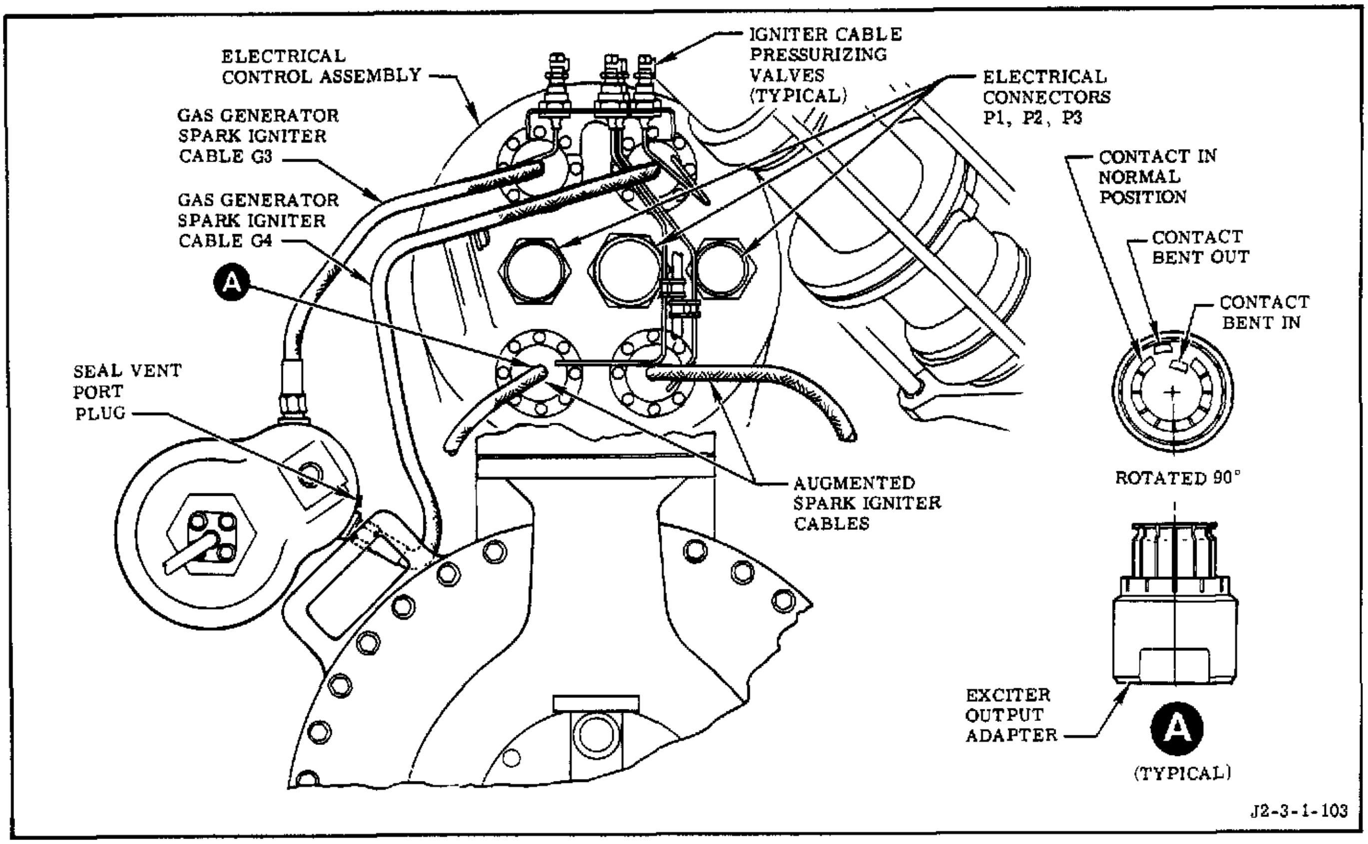


Figure 3-27. Gas Generator Spark Igniter Cables

d. Remove the 4 pressurizing valves (paragraph 3-245B).

e. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG SIC and remove bracket.

CAUTION

Care must be taken throughout this procedure to prevent damage to the SIC pressurizing lines.

f. Remove remaining bolts and washers that attach GG SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the insulator is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on SIC or prying on bell housing can damage SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 may dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

g. Remove GG SIC bell housing from ECA by pulling straight out until insulator clears exciter output adapter. Use care to prevent damage to SIC and ECA.

gA. Visually inspect GG SIC insulator and ECA exciter ceramic insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found, part containing breakdown path (SIC insulator and/or ECA) must be replaced.

CAUTION

Failure to counter frictional forces generated by removing the grommet can dislodge the bushing from the antirotation ring in SIC NA5-27448. A dislodged bushing can prevent pressurization of the SIC.

gB. On SIC NA5-27448 or NA5-27448T1, wearing clean nylon gloves remove grommet from insulator and discard grommet. On SIC NA5-27448, maintain finger pressure against insulator while removing grommet.

gC. Make sure a SIC sealing grommet is not in ECA exciter output adapter cavity and cavity is free of any foreign material.

h. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support ST3950166RKL001 on SIC bell housing so that plastic plunger in support is seated in SIC connector; install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

hA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

hB. Install clean protective closures (paragraph 3-258) on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

i. If spark igniter cable is to be replaced, heat splice on pressurizing line, remove pressurizing boss and line, and remove sleeve from stub-out line on spark igniter cable bell housing.

CAUTION

Care must be taken during the heating process to avoid overheating components and to prevent the molten brazing alloy from contacting and burning other engine components.

j. Remove support clamps from GG spark igniter cable except do not remove clamps that clamp pressurizing line to spark igniter cable. Note position of clamps for reinstallation.

CAUTION

Twisting spark igniter cables or bending cables on a radius of less than 4 inches can result in damage to the spark igniter cable bellows.

k. Remove spark igniter cable from GG combustor and remove spark igniter cable from engine. Take care not to twist or damage spark igniter cables or adjacent components. Keep bend radius of G3 spark igniter cable greater than 4 inches. Install clean protective closures on all open ports (paragraph 3-258).

3-110. INSTALLING GAS GENERATOR SPARK IGNITER CABLES. The GG spark igniter cable (figure 3-27) G3 may be reinstalled or replaced. (The bend radius of the cable must be kept greater than 4 inches during installation.) The GG spark igniter cable G4 must be replaced. Once cable G4 is installed and removed, it must not be reinstalled on any engine. Due to the sharp bend radius of cable G4 and the turning and flexing of the cable during installation and removal, the cable bellows may fatigue and crack with repeated installations.

a. Obtain a milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

bA. Remove closures from GG SIC bell housing and visually inspect GG SIC insulator for a breakdown path (sharply defined black or dark gray line). If a breakdown path is found on cable insulator, replace insulator (R-3825-3, Volume II). Replace closures on GG SIC bell housings.

c. Cut lockwire and remove spark igniter cable G4 seal bleed plug and seal from GG combustor.

d. Remove protective closures from spark igniter cable G4 boss in GG combustor and from threaded end of spark igniter cable G4. Make sure threads on igniter cable and mating boss in GG combustor are clean and free of damage. Make sure spark igniter cable is clean, free of damage, and OK to install. Note if threads on spark igniter cable have been dry-film lubricated (threads will have a blue-black cast).

e. Position spark igniter cable on engine, and install seal on threaded end of cable. Insert cable in boss on GG combustor and maintain a slight pressure on cable to prevent it from falling out of boss.

CAUTION

Turning spark igniter cable G4 more than 15 revolutions during installation can result in damage to igniter cable bellows.

f. Carefully engage first threads of cable and combustor, to avoid unnecessary revolutions. Screw cable into GG combustor by hand, counting revolutions, until seal is seated against combustor and cable is fingertight. Do not turn cable more than 15 revolutions. If 15 revolutions are exceeded, replace spark igniter cable G4.

g. If threads on spark igniter cable have been dry-film lubricated (threads have a blue-black color), torque spark igniter cable to 60-80 in-lb. If threads have not been lubricated, torque spark igniter cable to 100-150 in-lb.

h. Install seal and bleed plug in spark igniter cable G4 seal bleed port on GG combustor. Tighten plug fingertight.

NOTE

The bleed plug will be removed during leak test. Following leak test, the bleed plug will be reinstalled and torqued to 22-28 in-lb. During prelaunch leak test, the bleed plug will be safetywired.

i. Remove protective closures from spark igniter cable G3 boss in GG combustor and from threaded end of spark igniter cable G3. Make sure threads on igniter cable and mating boss in GG combustor are clean and free of damage, and OK to install. Note if threads on spark igniter cable have been dry-film lubricated (threads have a blue-black cast).

j. Install seal and SIC G3 on GG combustor keeping bend radius of cable greater than 4 inches. If threads on SIC have been dry-film lubricated (threads have a blue-black color), torque SIC to 60-80 in-lb. If threads have not been lubricated, torque cable to 100-150 in-lb.

k. As closures are removed (paragraph 3-257) from ECA, make sure each SIC connect point, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

l. Remove protective closures (paragraph 3-257) and support ST3950166RKL001 from SIC bell housing and exciter output adapter, only as each cable is installed.

m. Using a small wire brush or 320-grit (or finer) abrasive cloth or paper, remove any protective finishes from bonding surfaces of 4 SIC attaching bolts and bonding surfaces around 4 boltholes, approximately 90 degrees apart, on each SIC bell housing. Take care not to damage sealing surfaces.

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

n. Clean bonding and mating surfaces on SIC bell housing, ECA, and bell housing attaching bolts with a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602).

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

o. Purge pressurizing line in SIC bell housing and line on pressurizing valve boss with low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401) to remove any chips or foreign matter.

CAUTION

Care must be taken during the brazing process to avoid overheating or burning the SIC and adjacent components.

p. Braze pressurizing line in SIC bell housing to line on pressurizing valve boss, using a sleeve, gold-silver-copper-zinc brazing alloy, RB0170-089 (Rocketdyne), and flux mixture of 50 percent Handy flux and 50 percent Handy flux, Type B1 (Handy and Harman).

WARNING

Compressed gas must not be used for testing for obstructions unless effective chip guarding and personal protection equipment is worn.

q. Apply a low-pressure (less than 30 psig) purge to SIC pressurizing line to make sure brazing material did not block line.

r. Inspect exciter output adapters for bent or broken contacts (figure 3-27) as follows:

(1) Contacts bent less than 0.070 inch from normal position are acceptable. Do not attempt to straighten bent contacts.

(2) Contacts bent 0.070 inch or more from normal position must be broken off (bend contact back and forth) and discarded.

(3) Adapters that have no more than 2 broken contacts are acceptable.

(4) If any one adapter has more than 2 broken contacts, replace ECA.

s. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

t. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

u. Install GG SIC on ECA as follows:

(1) Wearing clean nylon gloves and making sure cable movement is held to a minimum, install a new sealing grommet on connector with beveled end of grommet toward spring.

CAUTION

The SIC insulator must be centered over the exciter output adapter and pressed straight in, to prevent breakage or distortion of output adapter fingers.

(2) Center SIC insulator over exciter output adapter with pressurizing line alined with pressurizing lines from bell housings G1 and G2, and press bell housing down so that insulator goes straight into exciter output adapter.

(3) Install 2 bolts, with washers, fingertight into holes that are in line with centers of bell housings G3 and G4. If these holes are cleaned for bonding, make sure bolts cleaned for bonding are used.

v. Position bracket on SIC pressurizing line bosses, and secure bracket and SIC bell housing to ECA with bolts. Tighten bolts fingertight.

w. Install remaining bolts and washers on SIC bell housing. Make sure bolts cleaned for bonding are installed in holes that have surrounding area cleaned for bonding. Tighten bolts fingertight.

x. Cross-torque bolts that secure SIC to ECA, in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire.

y. Lubricate (Method A, section I) exterior threads of pressurizing bosses with lubricant grease RB0140-012 (Rocketdyne), and install washers and nuts on pressurizing bosses. Torque nuts to 290 ±10 in-lb and safetywire.

z. Install the 4 pressurizing valves (paragraph 3-245C).

aa. Using milliohmmeter, measure resistance between ECA and thrust chamber. Resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded junctures if thrust chamber or ECA structure is suspect for excessive resistance.

ab. Using milliohmmeter, measure resistance between any one of the 4 bonded bolts that secure each GG SIC bell housing to ECA. Resistance must not exceed 10 milliohms. Measurement may be made as close as possible to bonded junctures if bolt or ECA structure is suspect for excessive resistance. Complete step ac within 24 hours of completion of resistance checks (steps aa and ab); otherwise repeat steps aa and ab.

ac. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonded areas.

ad. Install SIC support clamps as follows: (Refer to R-3825-4 for clamp sizes and locations.)

NOTE

SIC support clamps may vary in size from cable to cable and from one location to another on the same cable, depending on the thickness of cable protective covering (armor braid and heat-shrinkable or tape-wrapped ablative covering).

(1) Install clamps that will support the SIC but will not compress or deform SIC protective covering.

(2) Torque screws in support clamps to 24-30 in-lb. The installed cable bend radii must be 2.00 inches or greater.

ae. Leak-test and pressurize SIC as outlined in R-3825-1B.

af. Refer to section IV for test requirements.

3-111. <u>GIMBAL.</u>

3-112. REMOVING GIMBAL (ENGINE HANDLER). The gimbal can be removed and reinstalled but cannot be replaced without affecting engine alinement.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove gimbal boot.

CAUTION

In the following steps, if the adjustment bolt or adjustment screw is turned, the engine requires realinement.

c. Remove lockwire from 4 gimbal attach bolts.

d. If adjustment bolt and adjustment screw are safetywired to gimbal attach bolts, remove lockwire and safetywire adjustment bolt and adjustment screw to gimbal. Apply seal on lockwire.

e. Scribe gimbal misalinement plate location with respect to injector dome (4 places) as shown in figure 3-28. Paint surface to be scribed, with machinist's blue ink, and scribe using a sharp metal scribe.

f. Support gimbal (77 pounds), remove 4 gimbal attach bolts and 4 eccentric washers, and carefully remove gimbal from engine, making sure not to damage spark igniter cables.

g. Install protective closures (paragraph 3-258) on gimbal.

3-113. REMOVING GIMBAL (UNSTACKED STAGE). The gimbal can be removed and reinstalled but cannot be replaced without affecting engine alinement.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove gimbal boot.

CAUTION

In the following steps, if the adjustment bolt or adjustment screw is turned, the engine requires realinement.

c. Remove lockwire from 4 gimbal attach bolts.

d. If adjustment bolt and adjustment screw are safetywired to gimbal attach bolts, remove lockwire and safetywire adjustment bolt and adjustment screw to gimbal. Apply seal on lockwire.

e. Scribe gimbal misalinement plate location with respect to injector dome (4 places) as shown in figure 3-28. Paint surface to be scribed, with machinist's blue ink, and scribe using a sharp metal scribe.

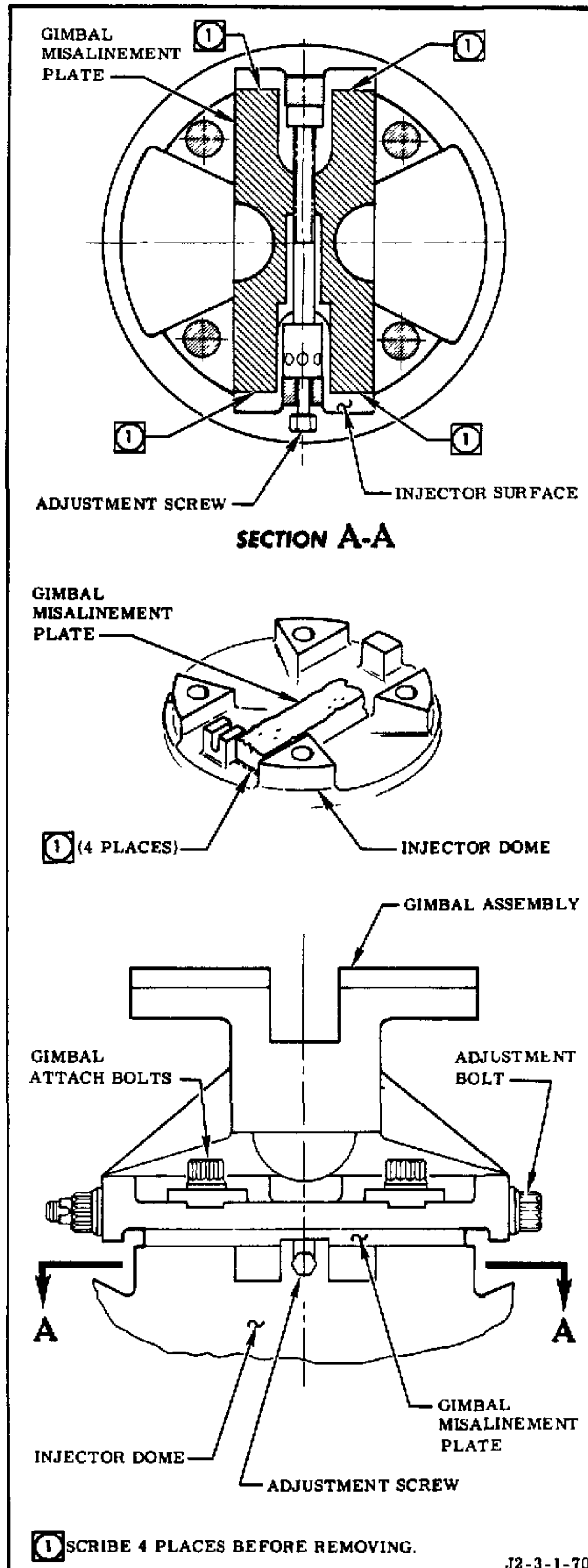


Figure 3-28. Gimbal

CAUTION

Lowering the engine in excess of 4 inches with electrical and fluid interface lines connected can result in damage to the engine.

f. Lower engine as outlined in section II. The engine must be lowered a minimum of 2. 5 inches to accomplish the following procedure. If desired, engine may be lowered to 4 inches maximum with electrical and fluid interface lines connected.

g. When required in the lowering procedure, break torque on 4 gimbal attach bolts and loosen each bolt a maximum of one turn.

h. Support gimbal (77 pounds), remove 4 gimbal attach bolts and 4 eccentric washers, and carefully remove gimbal from engine, making sure not to damage spark igniter cables.

i. Install clean protective closures (paragraph 3-258) on gimbal.

3-114. REMOVING GIMBAL (STACKED SII STAGE). The gimbal may be removed and reinstalled but cannot be replaced without affecting engine alinement.

a. Obtain the following: (Items 2 through 7 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4071, shelf 2

(2) Engine component handler 9024539 from engine components installer set 9026251

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Hanger 9024543 from engine components installer set 9026251

(7) Pickup adapter 9024547 from engine components installer set 9026251

(8) Components handling cart 9026253-11 from engine components installer set 9026251

(9) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track (section V) around engine from which gimbal is to be removed. Install turntable with controls leading, and position hoist at track station 13. 5 for engine positions 1 through 4, or track station 20 for engine position 5.

d. Remove fuel inlet duct (paragraph 3-58) and oxidizer inlet duct (paragraph 3-218) from engine position (1 through 4) from which gimbal is to be removed. Disconnect inlet ducts for engine position 5, using applicable Stage Contractor procedures.

e. Remove gimbal boot.

CAUTION

Lowering the engine in excess of 4 inches with electrical and fluid interface lines connected can result in damage to the engine.

f. Lower engine as outlined in section II. Engine must be lowered a minimum of 2. 5 inches to accomplish the following procedure. If desired, engine may be lowered to 4 inches maximum with electrical and fluid interface lines connected.

g. Scribe gimbal misalinement plate location with respect to injector dome (4 places) as shown in figure 3-28. Paint surfaces to be scribed with machinist's blue ink, and scribe using a sharp metal scribe.

CAUTION

In the following steps, if the adjustment bolt or adjustment screw is rotated, the engine requires alinement.

h. When required in the lowering procedure, break torque on 4 gimbal attach bolts and loosen

each bolt a maximum of one turn. If adjustment bolt and adjustment screw are safetywired to gimbal attach bolts, remove lockwire and safetywire adjustment bolt and adjustment screw to gimbal, taking care not to rotate either the adjustment bolt or adjustment screw.

i. Remove gimbal attach bolts making sure not to damage spark igniter cables.

j. Disassemble handler 9027263 by separating extension from handler. Attach extension to boom and straddle gimbal with handler as shown in figure 3-29. Handler is to be positioned to extend over engine between MOV and oxidizer turbopump.

k. Attach boom with extension (step j) to handler. Manipulate hoist to effect as short a coupling between extension and handler portions of handler 9027263 as possible, and pin the 2 parts of handler together.

l. Raise and remove gimbal (77 pounds).

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps n through v; otherwise, omit step m.

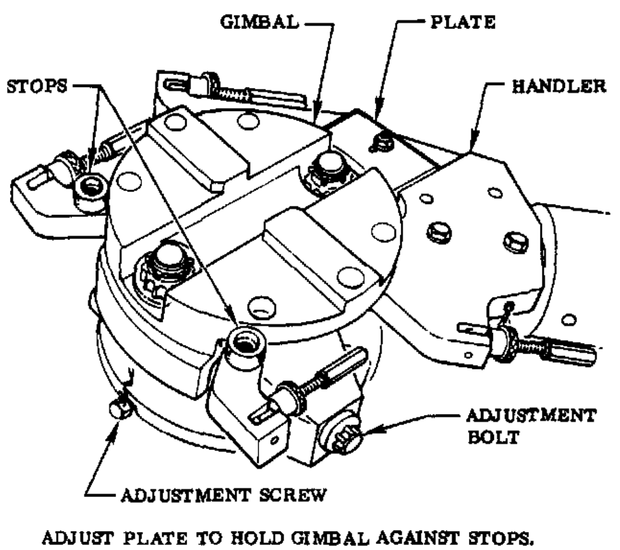


Figure 3-29. Gimbal Handler Installed

m. Using hoist, transfer gimbal through stage access door and lower into component handling cart.

n. Place hanger in an accessible area near stage access door and within 35-40 inches of track.

o. Attach pickup adapter to hanger and secure with ball-lock pin.

p. Attach handler 9024539 on cleared area of gimbal using inner bolts and clamping nuts. Torque bolts 145-185 in-lb.

q. Using hoist, transfer gimbal onto hanger. Secure handler 9024539 to pickup adapter with ball-lock pin.

r. Remove handler 9027363 from hoist boom, and install chain-hoist. Secure with ball-lock pin.

s. Maintain or note configuration of handler 9027263 for gimbal reinstallation.

t. Attach shackle G-209-9-1/2 or G-210-9-1/2 (Crobsy-Laughlin, Inc), or equivalent, to pickup adapter. Do not install shackle in pickup adapter slot.

u. Connect chain-hoist chain to shackle.

v. Using hoist and chain-hoist, remove gimbal from hanger and transfer gimbal through stage access door. Lower gimbal into component handling cart.

w. Install clean protective closures (paragraph 3-258) on gimbal.

3-115. REMOVING GIMBAL (STACKED SIVB STAGE). The gimbal may be removed and reinstalled but cannot be replaced without affecting engine alinement.

a. Obtain gimbal and injector handler 9027263 from Engine Components Installer G4072, shelf 2.

b. Assemble track (section V) for gimbal removal. Install turntable with controls trailing.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove fuel inlet duct (paragraph 3-58) and oxidizer inlet duct (paragraph 3-218) from engine.

e. Remove gimbal boot.

CAUTION

Lowering the engine in excess of 4 inches with electrical and fluid interface lines connected can result in damage to the engine.

f. Install engine lowering system. (Refer to section V.) Engine must be lowered a minimum of 2.5 inches to accomplish the following procedure. If desired, engine may be lowered to 4 inches maximum with electrical and fluid interface lines connected.

g. Scribe gimbal misalinement plate location with respect to injector dome (4 places) as shown in figure 3-28. Paint surfaces to be scribed with machinist's blue ink, and scribe using a sharp metal scribe.

CAUTION

In the following steps, if the adjustment bolt or adjustment screw is rotated, the engine requires alinement.

h. Break torque on 4 gimbal attach bolts and loosen each bolt a maximum of one turn. If adjustment bolt and adjustment screw are safetywired to gimbal attach bolts, remove lockwire and safetywire adjustment bolt and adjustment screw to gimbal, taking care not to rotate either the adjustment bolt or the adjustment screw.

i. Refer to section II for procedures to lower engine.

j. Remove gimbal attach bolts and 4 eccentric washers making sure not to damage ASI propellant lines or cables.

k. Attach handler to hoist, and extend adapter to 6th positioning hole. Secure with ball-lock pin.

l. Manipulate hoist and straddle gimbal with handler as shown in figure 3-29. Handler is to be positioned to extend over engine between MOV and oxidizer turbopump.

m. Raise and remove gimbal (77 pounds), passing gimbal between oxidizer turbopump and MOV.

n. Using hoist, transfer gimbal to stage exit.

o. Install clean protective closures (paragraph 3-258) on gimbal.

p. Remove gimbal from hoist and manually carry gimbal from stage.

3-116. INSTALLING GIMBAL (ENGINE HANDLER). The gimbal can be removed and reinstalled but cannot be replaced without affecting engine alinement.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from gimbal and injector dome. Make sure gimbal is clean, free of damage, and OK to install. Make sure mating surface of injector dome, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

c. Carefully position gimbal on injector dome, making sure not to damage igniter cables.

d. Install 4 eccentric washers and 4 gimbal attach bolts. Tighten bolts fingertight.

e. Aline gimbal misalinement plate with scribe marks on injector dome. (See figure 3-28.) Torque gimbal attach bolts to 143-158 ft-lb.

f. Recheck alinement of scribe marks to make sure gimbal did not move during torquing operation. If gimbal did move (scribe marks are not alined), loosen bolts and repeat step e. Safetywire the 4 gimbal attach bolts.

g. Install gimbal boot. Torque clamp bolts to 6-8 in-lb.

3-117. INSTALLING GIMBAL (UNSTACKED STAGE). The gimbal may be reinstalled but not replaced without affecting engine alinement.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from gimbal and injector dome. Make sure gimbal is clean, free of damage, and OK to install. Make sure mating surface of injector dome, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

c. Using suitable equipment, carefully position gimbal (77 pounds) on injector dome, making sure not to damage igniter cables.

d. Install 4 eccentric washers and 4 gimbal attach bolts. Tighten bolts fingertight.

e. Aline gimbal misalinement plate to scribe marks on injector dome (figure 3-28). Torque gimbal attach bolts to 143-158 ft-lb.

f. Recheck alinement of scribe marks to make sure gimbal did not move during torquing operation. If gimbal did move (scribe marks are not alined), loosen bolts and repeat step e. Safetywire the 4 gimbal attach bolts.

g. Refer to section II for procedures to raise engine.

h. Install gimbal boot. Torque clamp bolts to 6-8 in-lb.

3-118. INSTALLING GIMBAL (STACKED SII STAGE). The gimbal can be removed and reinstalled but cannot be replaced without affecting engine alinement.

a. Obtain the following: (Items 3 through 8 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4071, shelf 2

(2) Engine component handler 9024539 from engine components installer set 9026251

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Hanger 9024543 from engine components installer set 9026251

(7) Pickup adapter 9024547 from engine components installer set 9026251

(8) Handling cart 9026253-11 from engine components installer set 9026251

(9) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257) from gimbal, and make sure gimbal is clean, free of damage, and OK to install.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps f through m; otherwise, omit steps d and e.

d. Secure gimbal in handler 9027263 as shown in figure 3-29; then connect hoist to handler.

e. Raise gimbal and transfer gimbal through stage access door.

f. Install handler 9024539 on gimbal using inner bolts and clamping nuts. Torque bolts to 145-185 in-lb.

g. Attach pickup adapter to handler 9024539. Attach shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent to pickup adapter. Do not attach shackle in pickup adapter slot.

h. Position hoist on track near stage access door, and install chain-hoist on hoist boom.

i. Move hoist boom through stage access door, and attach chain-hoist hook to shackle.

j. Raise gimbal and transfer gimbal through stage access door. Attach pickup adapter to hanger and secure with ball-lock pin.

k. Install handler 9027263 on gimbal as shown in figure 3-29.

l. Remove chain-hoist from hoist boom, and connect hoist boom to handler on gimbal.

m. Using hoist, remove gimbal from hanger. Remove pickup adapter and handler from gimbal.

CAUTION

During the remainder of this procedure, care must be taken when performing tasks near the igniter cables, to prevent damage to igniter cables.

n. Remove protective closure (paragraph 3-257) from injector dome mating surface. Make sure mating surface, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

o. Using hoist, place gimbal into position, passing it over engine between oxidizer turbopump and MOV, while working turntable toward track station 13.5 for engine positions 1 through 4, or track station 20 for engine position 5.

p. Lower gimbal onto injector dome, and install eccentric washers and gimbal attach bolts. Tighten bolts fingertight.

q. Remove handler 9027263 from gimbal.

r. Refer to section II for procedures to raise engine.

CAUTION

Thrust chamber can be damaged by striking stage structure.

s. Aline gimbal misalinement plate with scribe marks on injector dome (figure 3-28), and maintaining alinement, tighten gimbal attach bolts until bolts are seated and sufficiently tight to prevent movement between gimbal and injector dome. Restrain engine while tightening bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure.

t. Cross-torque gimbal attach bolts to 145-158 ft-lb. Apply torque in a minimum of 3 equal increments. Restrain engine while torquing, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be accomplished because of interference with engine lowering system, remove engine lowering system (step v), and then torque gimbal attach bolts.

u. Safetywire gimbal attach bolts.

v. Remove engine lowering system. (Refer to section V.)

w. Install gimbal boot. Torque clamp bolts to 6-8 in-lb.

x. Install oxidizer inlet duct (paragraph 3-218) and fuel inlet duct (paragraph 3-58) for engine positions 1 through 4; for engine position 5, install ducts using applicable Stage Contractor procedures.

y. If gimbal is being installed on engine position 5, connect liquid oxygen and liquid hydrogen recirculation bleed lines and liquid oxygen tank pressurization line.

3-119. INSTALLING GIMBAL (STACKED SIVB STAGE). The gimbal can be removed and reinstalled but cannot be replaced without affecting engine alinement.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain gimbal and injector handler 9027263 from Engine Components Installer G4072, shelf 2.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257) from gimbal and make sure gimbal is clean, free of damage, and OK to install.

d. Position hoist with handler installed in an accessible area near stage access door. Manually carry gimbal into stage, and install gimbal in handler as shown in figure 3-29.

CAUTION

During the remainder of this procedure, care must be taken when performing tasks near the ASI propellant lines and cables, to prevent damage to propellant lines and cables.

e. Remove protective closure (paragraph 3-257) from injector dome mating surface. Make sure mating surface, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

f. Using hoist, place gimbal into position, passing gimbal between oxidizer turbopump and MOV, while working turntable toward MOV.

g. Lower gimbal onto injector dome and install eccentric washers and gimbal attach bolts. Tighten bolts fingertight.

h. Remove handler from gimbal.

i. Refer to section II for procedures to raise engine.

j. Secure gimbal to stage using applicable Stage Contractor procedures.

CAUTION

The thrust chamber can be damaged by striking the stage structure.

k. Aline gimbal misalinement plate with scribe marks on injector dome (figure 3-28), and maintaining alinement, tighten gimbal attach bolts until bolts are seated and sufficiently tight to prevent movement between gimbal and injector dome. Restrain engine while tightening bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure.

l. Cross-torque gimbal attach bolts to 145-158 ft-lb. Apply torque in approximately 50 ft-lb increments to 145-158 ft-lb. Restrain engine while torquing, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be accomplished because of inteference with engine lowering system, remove engine lowering system (step n), and then torque gimbal attach bolts.

m. Safetywire gimbal attach bolts.

n. Remove engine lowering system. (Refer to section V.)

o. Install gimbal boot. Torque clamp bolts to 6-8 in-lb.

p. Install fuel inlet duct (paragraph 3-58) and oxidizer inlet duct (paragraph 3-218).

3-120. HEAT EXCHANGER.

3-121. REMOVING HEAT EXCHANGER (ENGINE HANDLER OR UNSTACKED STAGE). The heat exchanger (figure 3-30) may be reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following:

(1) Oxidizer heat exchanger handler 9016790-11

(2) Adapter T-5044632

(3) Component handler universal lifting sling 9016780

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Cut oxidizer turbine exhaust pressure line (TG4). (Refer to section VI for tube cutting requirements.) Protect open line.

d. On engines not incorporating MD105 and MD194 change, accomplish the following:

(1) Cut oxidizer inlet pressure instrumentation line (HO1). (Refer to section VI for tube cutting requirements.) Protect open line.

(2) Remove bolts and washers that secure bypass line to antiflood check valve. Remove seal. Protect open ports and sealing surfaces.

(3) Remove clamps supporting oxidizer inlet line between thrust chamber and antiflood check valve.

(4) Using adapter T-5044632, remove bolts and washers that secure antiflood check valve to heat exchanger. Remove seal, and protect open ports and sealing surfaces. Move antiflood check valve until flanges just clear each other; then tie antiflood check valve securely in this position.

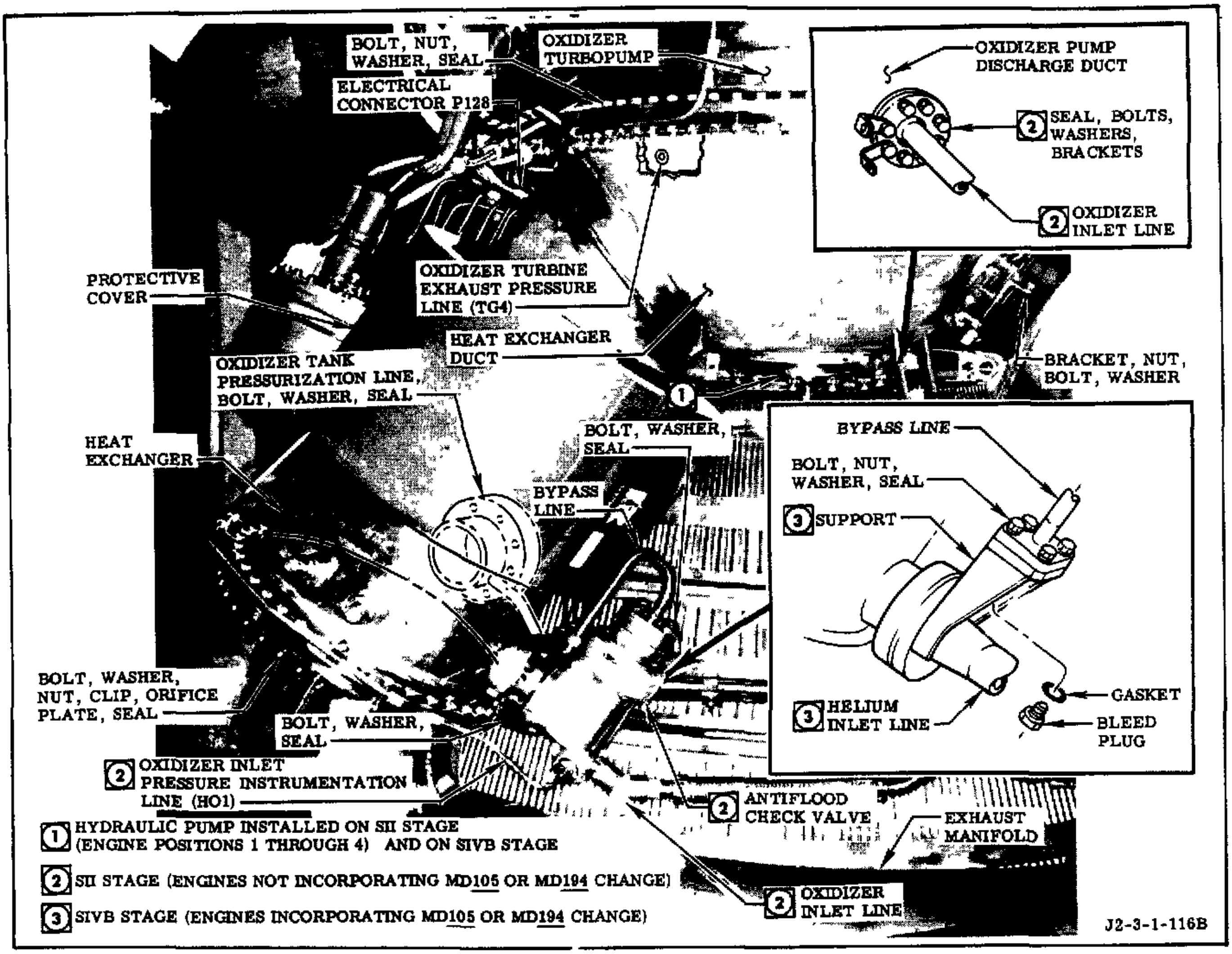


Figure 3-30. Heat Exchanger and Antiflood Check Valve

e. On engines incorporating MD105 or MD194 change, do the following:

(1) Remove nuts, bolts, and washers holding bypass line flange and seal to support.

(2) Remove nuts, bolts, and washers holding support, helium inlet line, and seal to heat exchanger inlet flange. Remove seal at bypass line flange. Protect open ports and sealing surfaces.

eA. Remove screw, nut, washer, and clamp from intermediate seal purge check valve.

f. Disconnect electrical connector (paragraph 3-30) P128.

g. Remove bolts and washers that secure oxidizer tank pressurization line to heat exchanger. Remove seal. Protect open ports and sealing surfaces.

h. Remove protective cover from heat exchanger bellows.

i. Install heat exchanger handler 9016790-11 and lifting sling 9016780. Attach a hoist to sling to support weight of heat exchanger (approximately 104 pounds).

j. Remove bolts, washers, clips, and nuts that secure heat exchanger to exhaust manifold.

k. Compress heat exchanger bellows by turning hand knobs on heat exchanger handler. Remove seal and orifice plate. The orifice plate is calibrated and must be retained for reinstallation. Protect open ports and sealing surfaces.

l. Remove bolts and washers that secure heat exchanger to oxidizer turbopump (mark location of brackets), remove seal, and slowly

lift heat exchanger from engine. Protect open ports and sealing surfaces.

m. Install adapter on oxidizer turbopump, and torque bolts that secure adapter to 25-30 in-lb.

NOTE

If turbopump is to be removed, use hole pattern that positions lifting lug on adapter nearest seal monitor port on turbine exhaust flange.

n. Install clean protective closures (paragraph 3-258) on all open ports.

3-122. REMOVING HEAT EXCHANGER (STACKED SII STAGE). The heat exchanger (figure 3-30) may be reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following: (Items 3 through 8 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Oxidizer heat exchanger handler 9016790-11.

(2) Adapter T-5044632.

(3) Component handler universal lifting sling 9016779.

(4) Chain-hoist 9027095 from engine components installer set 9026251.

(5) Universal joint S8 from engine components installer set 9026251.

(6) Extension bar SX-24 from engine components installer set 9026251.

(7) Hanger 9024543 from engine components installer set 9026251.

(8) Sling 6001-5-4 from Engine Components Installer G4071, shelf 3.

(9) Component handling cart 9026253-11 from engine components installer set 9026251.

(10) Ramps 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track (refer to section V) around engine from which heat exchanger is to be removed. Install turntable with controls leading, and position hoist at track station 21 for engine positions 1 through 4, or track station 17 for engine position 5.

d. Cut oxidizer turbine exhaust pressure line (TG4). (Refer to section VI for tube cutting requirements.) Protect open ends.

e. Disconnect antiflood check valve as follows:

(1) Cut oxidizer inlet pressure instrumentation line (HO1). (Refer to section VI for tube cutting requirements.) Protect open ends.

(2) Remove bolts and washers that secure bypass line to antiflood check valve. Remove seal. Protect open ports and sealing surfaces.

(3) Remove clamps supporting oxidizer inlet line between thrust chamber and antiflood check valve.

(4) Using adapter T-5044632, remove bolts and washers that secure antiflood check valve to heat exchanger. Remove seal, and protect open ports and sealing surfaces. Move antiflood check valve until flanges just clear each other; then tie antiflood check valve securely in this position.

f. Remove screw, nut, washers, and clamp from intermediate seal purge check valve.

g. (Deleted)

h. Disconnect electrical connector (paragraph 3-30) P128.

i. For engine positions 1 through 4, remove hydraulic pump, using applicable stage procedures. Protect open ports and sealing surfaces.

j. Remove bolts and washers that secure oxidizer tank pressurization line to heat exchanger. Remove seal. Protect open ports and sealing surfaces.

k. Remove protective cover from heat exchanger bellows.

l. Install handler on heat exchanger with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine; then connect boom to handler, to support weight of heat exchanger (approximately 104 pounds).

m. Remove bolts, washers, clips, and nuts that secure heat exchanger to exhaust manifold. Mark location of clamps for oxidizer inlet pressure instrumentation line (HO1).

n. Compress heat exchanger bellows by turning handknobs on heat exchanger handler. Remove seal and orifice plate. The orifice plate is calibrated and must be retained for reinstallation.

o. Remove bolts and washers that secure heat exchanger to oxidizer turbopump (mark location of brackets), remove seal, and slowly lift heat exchanger from engine.

p. Install adapter on oxidizer turbopump, and torque bolts that secure adapter to 25-30 in-lb.

NOTE

If turbopump is to be removed, use hole pattern that positions lifting lug on adapter nearest seal monitor port on turbopump exhaust flange.

q. Install clean protective closures (paragraph 3-258) on all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps s through z; otherwise omit step r.

r. Using hoist, transfer heat exchanger through stage access door and lower into component handler cart.

s. Place hanger in an accessible area near stage access door.

t. Using hoist, move heat exchanger to hanger.

u. Install sling 6001-5-4 on heat exchanger between duct inlet and bellows using a choker hitch.

v. Attach heat exchanger to hanger with sling 6001-5-4. Secure with ball-lock pin.

CAUTION

The heat exchanger must be restrained when removing the hoist, to prevent the heat exchanger from striking the hanger or stage work deck.

w. Remove hoist from handler. Manually restrain heat exchanger while removing hoist, to prevent sudden movement of heat exchanger.

x. Install sling 9016779 on handler.

y. Install chain-hoist on hoist, and connect hook to sling 9016779.

z. Slowly raise heat exchanger, remove sling 6001-5-4, and transfer heat exchanger through stage access door. Lower heat exchanger onto component handling cart.

3-123. REMOVING HEAT EXCHANGER (STACKED SIVB STAGE). The heat exchanger (figure 3-30) may be reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following:

(1) Oxidizer heat exchanger handler 9016790-11

(2) Extension 9027080 from Engine Components Installer G4072, shelf 5

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

(4) Component handler universal lifting sling 9016779

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track for heat exchanger removal, as required for applicable stage. (Refer to section V.) Install turntable with controls trailing.

d. Cut oxidizer turbine exhaust pressure line (TG4). (Refer to section VI for tube cutting requirements.) Protect open ports and sealing surfaces.

e. Remove screw, nut, washers, and clamp from intermediate seal purge check valve.

f. Remove nuts, bolts, and washers holding bypass line flange and seal to support.

g. Remove nuts, bolts, and washers holding support, helium inlet line, and seal to heat exchanger inlet flange. Remove seal at bypass line flange. Protect open ports and sealing surfaces.

h. Disconnect electrical connector (paragraph 3-30) P128.

i. Remove hydraulic pump, using applicable stage procedures. Protect open ports and sealing surfaces.

j. Remove bolts and washers that secure oxidizer tank pressurization line to heat exchanger. Remove seal. Protect open ports and sealing surfaces.

k. Remove all but 3 bolts from flanges connecting heat exchanger to oxidizer turbopump and the heat exchanger to exhaust manifold. Remaining bolts that secure flanges should be easily accessible and equally distributed around flanges.

l. Remove protective cover from heat exchanger bellows.

m. Install handler on heat exchanger with end supports straddling bellows and with handknob down. Aline index marks on handler with instrumentation ports, as noted on handler.

n. Remove remaining 3 bolts, washers, and nuts that secure heat exchanger to exhaust manifold.

o. Compress heat exchanger bellows by turning handknobs on heat exchanger handler. Remove seal and orifice plate. The orifice plate is calibrated and must be retained for reinstallation.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

p. Install sleeve and extension on hoist. (See figure 3-6, view G.) Position extension in 9th (farthest from extension turnbuckle) positioning hole. Secure with ball-lock pin.

q. Attach extension to heat exchanger handler and secure with ball-lock pin.

r. Manipulate hoist controls and extension turnbuckle to support a portion of heat exchanger weight with hoist. Do not attempt to support full weight of heat exchanger (approximately 104 pounds). Manipulate hoist controls and extension turnbuckle to effect a near vertical lift, to minimize side loads. If extension turnbuckle is extended, do not extend it beyond a minimum of one thread evident in turnbuckle barrel.

NOTE

With the heat exchanger suspended from the extension, distance and deflection forces prevent the hoist operator from having adequate visibility and the precise control required to safely manipulate the heat exchanger out of the congested environment. Therefore, until the heat exchanger is clear, a technician will be required to observe and guide the heat exchanger and to assist the hoist operator.

s. Incrementally loosen and remove the 3 remaining bolts that secure heat exchanger to oxidizer turbopump. Monitor gap as heat exchanger separates from turbopump to ascertain whether hoist is supporting a sufficient portion of weight to prevent a sudden separation and to make sure that a side load does not exist.

t. Remove seal between heat exchanger and turbopump.

u. Using hoist, move heat exchanger away from engine and to the right until clear of engine and until both heat exchanger and hoist are to right of access work platform.

v. Install adapter on oxidizer turbopump, and torque bolts that secure adapter to 25-30 in-lb.

NOTE

If turbopump is to be removed, use hole pattern that positions lifting lug on adapter nearest seal monitor port on turbopump exhaust flange.

w. Remove access work platform from installed position, and temporarily store platform in stage.

x. Using hoist, raise heat exchanger through opening provided by removal of access work platform. Move heat exchanger away from opening.

y. Using hoist, move heat exchanger to an accessible area near stage access door.

z. Remove handler (with heat exchanger attached) from hoist and temporarily place on protective pad. Install sling on handler and secure with ball-lock pin.

aa. Using lifting eye on sling, manually carry heat exchanger from stage.

ab. Install clean protective closures (paragraph 3-258) on all open ports.

3-124. INSTALLING HEAT EXCHANGER (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-30.) Only the heat exchanger removed can be reinstalled without affecting engine calibration.

a. Obtain the following:

(1) Oxidizer heat exchanger handler 9016790-11

(2) On engines not incorporating MD105 or MD194 change, adapter T-5044632.

(3) Component handler universal lifting sling 9016780

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure heat exchanger, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Install heat exchanger handler 9016790-11 and lifting sling 9016780. Compress heat exchanger bellows by turning handknobs on heat exchanger handler, and position heat exchanger on engine.

e. Remove protective covering from heat exchanger and oxidizer turbopump mating flanges, and install seal on heat exchanger flange. Secure heat exchanger to oxidizer turbopump with bolts, nuts, and washers making sure brackets removed are reinstalled. Tighten nuts fingertight.

f. Cross-torque nuts at turbopump flange to 78-84 in-lb and safetywire.

NOTE

Because of boss interference at the exhaust manifold end of the heat exchanger, it may be necessary to install three bolts with the heads on the exhaust duct flange instead of on the heat exchanger flange.

- Separating the joint connected in step g is required for leak testing the turbine exhaust system as specified in R-3825-1B. Therefore, the turbine exhaust system can be leak tested prior to step g if the oxidizer turbine exhaust pressure line (TG4) is reconnected (steps lA and m) prior to leak testing.

g. Remove protective covering, install orifice plate and seal at exhaust manifold end of heat exchanger, and secure with bolts, washers, clips, and nuts. Install orifice plate with flat side toward heat exchanger. Loosen handknobs on heat exchanger handler, and torque nuts to 76-84 in-lb.

h. On engines not incorporating MD105 or MD194 change, accomplish the following:

(1) Remove protective covering, install seal and antiflood check valve on heat exchanger, and secure with bolts and washers. Using adapter T-5044632 (refer to section I), cross-torque bolts to 95-105 in-lb and safetywire.

(2) Remove protective covering, install seal and bypass line to antiflood check valve, and secure with bolts and washers. Torque bolts to 48-53 in-lb and safetywire.

(2A) Torque oxidizer inlet pressure instrumentation line (HO1) adapter to 67 in-lb. If adapter did not move, proceed to next step. If adapter moved, remove and replace adapter and seal, and torque adapter to 67-73 in-lb.

(3) Remove protective material and weld oxidizer inlet pressure instrumentation line (HO1). *(Refer to section VI for tube welding* requirements.)

i. On engines incorporating MD105 or MD194 change, accomplish the following:

(1) Remove protective covering from heat exchanger and helium inlet line flanges.

(2) Install helium inlet line, seal, and support with bolts, washers, and nuts. Cross-torque nuts to 95-105 in-lb.

(3) Remove protective covering from bypass line flange and support flange.

(4) Install bypass line and seal to support with bolts, washers, and nuts. Torque nuts to 57-68 in-lb.

(5) Make sure bleed plug and gasket are installed in support or opposite side of bypass line flange. Torque for bleed plug is 22-28 in-lb.

j. Remove protective material from mating flanges of oxidizer tank pressurization line and heat exchanger, and install oxidizer tank pressurization line with seal, bolts, and washers. Torque bolts to 48-53 in-lb and safetywire.

k. Remove sling and handler.

l. Install protective cover on heat exchanger bellows.

lA. Torque oxidizer turbine exhaust pressure line (TG4) adapter to 67 in-lb. If adapter did not move, proceed to next step. If adapter moved, remove and replace adapter and seal, and torque adapter to 67-73 in-lb.

m. Remove protective material and weld oxidizer turbine exhaust pressure line (TG4.) (Refer to section VI for tube welding requirements.)

n. Install electrical connector (paragraph 3-31) P128.

o. Refer to section IV for test requirements.

3-125. INSTALLING HEAT EXCHANGER (STACKED SII STAGE). (See figure 3-30.) Only the heat exchanger removed can be reinstalled without affecting engine calibration.

a. Obtain the following: (Items 3 through 8 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Oxidizer heat exchanger handler 9016790-11

(2) Torque wrench adapter T-5044632

(3) Component handler universal lifting sling 9016779

(4) Chain-hoist 9027095

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Hanger 9024543 from engine components installer set 9026251

(8) Sling 6001-5-4 from Engine Components Installer G4071, shelf 3

(9) Component handler cart 9026253-11 from engine components installer set 9026251

(10) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure heat exchanger, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Install handler on heat exchanger with end supports straddling bellows and with handknob down. Aline index marks on handler with instrumentation ports as noted on handler.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps g through p; otherwise, omit steps e and f.

e. Connect handler to hoist boom and secure with ball-lock pin.

f. Using hoist, raise heat exchanger and transfer heat exchanger through stage access door.

g. Install sling 9016779 on handler and secure with ball-lock pin.

h. Position hoist on track near stage access door, and install chain-hoist on hoist.

i. Move hoist boom through stage access door. Lower and attach chain-hoist hook to lifting ring on sling 9016779.

j. Raise duct and transfer heat exchanger through stage access door to hanger.

k. Install sling 6001-5-4 on heat exchanger between duct inlet and bellows, using a choker hitch.

CAUTION

The heat exchanger must be restrained when removing the hoist, to prevent the heat exchanger from striking the hanger or stage work deck.

l. Attach heat exchanger to hanger with sling 6001-5-4. Secure with ball-lock pin.

m. Remove chain-hoist hook from sling 9016779. Remove sling from handler.

n. Remove chain-hoist from hoist.

o. Connect hoist to handler and secure with ball-lock pin.

p. Using hoist, slowly raise heat exchanger. Remove sling 6001-5-4.

q. Position hoist at track station 21 for engine positions 1 through 4, or track station 17 for engine position 5.

r. Remove protective closures (paragraph 3-257).

s. Using hoist, move heat exchanger into position on engine.

t. Remove protective covering, install seal at turbopump end of heat exchanger, and secure duct to turbopump with bolts, nuts, and washers making sure brackets removed are reinstalled. Tighten nuts fingertight.

u. Install bracket on oxidizer pump torque access plate and secure with bolts, nuts, and washers. Tighten bolts fingertight.

v. Cross-torque nuts at turbopump flange to 76-84 in-lb. Torque the 3 bolts that secure bracket to access plate to 40-50 in-lb and safetywire.

NOTE

Because of boss interference at the exhaust manifold end of the heat exchanger, it may be necessary to install 2 bolts with the heads on the exhaust duct flange instead of on the heat exchanger flange.

- Separating the joint connected in step w is required for leak testing the turbine exhaust system as specified in R-3825-1B. Therefore, the turbine exhaust system can be leak tested prior to step w if the oxidizer turbine exhaust pressure line (TG4) is reconnected (steps abA and ac) prior to leak testing.

w. Remove protective covering and install orifice plate and seal at exhaust manifold end of heat exchanger. Install orifice plate with flat side toward heat exchanger. Loosen handknobs on heat exchanger handler and secure duct to exhaust manifold with bolts, washers, clips, and nuts. Torque nuts to 76-86 in-lb.

x. Remove protective covering and install seal between antiflood check valve and flange on heat exchanger. Secure valve to heat exchanger with bolts and washers. Using torque wrench adapter (refer to section I), cross-torque bolts to 95-105 in-lb and safetywire.

y. Remove protective covering, install seal and bypass line to antiflood check valve, and secure with washers and bolts. Torque bolts to 48-53 in-lb and safetywire.

z. Remove protective covering, and install oxidizer tank pressurization line with seal, washers, and bolts. Torque bolts to 48-53 in-lb and safetywire.

aa. Remove handler from heat exchanger.

ab. Install protective cover on heat exchanger bellows.

abA. Torque oxidizer turbine exhaust pressure line (TG4) adapter and oxidizer inlet pressure instrumentation line (HO1) adapter to 67 in-lb. If either adapter did not move, proceed to next step. If either or both adapters moved, remove and replace adapter (that moved) and seal, and torque adapter to 67-73 in-lb.

ac. Remove protective covering, weld oxidizer turbine exhaust pressure line (TG4), and oxidizer inlet pressure instrumentation line (HO1). (Refer to section VI for tube welding requirements.)

ad. Disassemble track. (Refer to section V.)

ae. Connect electrical connector (paragraph 3-31) P128.

af. For engine positions 1 through 4, install hydraulic pump using Stage Contractor procedures.

ag. Refer to section IV for test requirements.

3-126. INSTALLING HEAT EXCHANGER (STACKED SIVB STAGE). (See figure 3-30.) Only the heat exchanger removed can be reinstalled without affecting engine calibration.

a. Obtain the following:

(1) Oxidizer heat exchanger handler 9016790-11

(2) Extension 9027080 from Engine Components Installer G4072, shelf 5

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

(4) Component handler universal lifting sling 9016779

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Manually carry heat exchanger (approximately 104 pounds) into stage and place on protective pad. A suggested method of handling the heat exchanger is as follows:

(1) Install handler on heat exchanger with end supports straddling bellows and with handknob down.

(2) Aline index marks on handler with instrumentation ports as indicated on handler.

(3) Wrap handler straps around heat exchanger and secure.

(4) Attach sling on handler and secure with ball-lock pin.

d. Remove protective closures (paragraph 3-257). Make sure heat exchanger, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure turnbuckle operates safely.

e. Install sleeve and extension on hoist. (See figure 3-6, view G.) Position extension in 9th (farthest from extension turnbuckle) positioning hole. Secure with ball-lock pin.

f. Position heat exchanger upright and attach extension to heat exchanger handler.

NOTE

With the heat exchanger suspended from the extension, distance and deflection forces prevent the hoist operator from having adequate visibility and the precise control required to safely manipulate the heat exchanger into the congested environment. Therefore, until the heat exchanger is installed, a technician will be required to observe and guide the heat exchanger and to assist the hoist operator.

g. Using hoist, slowly move heat exchanger down through opening provided by removal of stage work deck and into position on engine. Adjusting extension turnbuckle will aid in positioning heat exchanger during lowering. Do not extend turnbuckle beyond maximum length (one thread in adjusting barrel evident).

h. Compress heat exchanger bellows by turning handknobs on handler.

i. Remove protective covering and install seal at turbopump end of heat exchanger. Secure duct to turbopump with bolts, nuts, and washers making sure brackets removed are reinstalled. Tighten nuts fingertight.

j. Cross-torque nuts at turbopump flange to 76-84 in-lb.

NOTE

Because of boss interference at the exhaust manifold end of the heat exchanger, it may be necessary to install two bolts with the heads on the exhaust duct flange instead of on the heat exchanger flange.

- Separating the joint connected in step k is required for leak testing the turbine exhaust system as specified in R-3825-1B. Therefore, the turbine exhaust system can be leak tested prior to step k if the oxidizer turbine exhaust pressure line (TG4) is reconnected (steps sA and t) prior to leak testing.

k. Remove protective covering and install orifice plate and seal at exhaust manifold end of heat exchanger. Install orifice plate with flat side toward heat exchanger. Loosen handknobs on heat exchanger handler and secure duct to exhaust manifold with bolts, washers, clips, and nuts. Torque nuts to 76-84 in-lb.

l. Remove protective covering from heat exchanger and oxidizer inlet line flanges.

m. Install helium inlet line, seal, and support with bolts, washers, and nuts. Cross-torque nuts to 95-105 in-lb.

n. Remove protective covering from bypass line flange and support flange.

o. Install bypass line and seal to support with bolts, washers, and nuts. Torque nuts to 57-68 in-lb.

p. Make sure bleed plug and gasket are installed in support on opposite side of bypass line flange. Torque for bleed plug is 22-28 in-lb.

q. Remove protective covering and install oxidizer tank pressurization line with seal, washers, and bolts. Torque bolts to 48-53 in-lb and safetywire.

r. Remove handler and hoist from heat exchanger.

s. Install protective cover on heat exchanger bellows.

sA. Torque oxidizer turbine exhaust pressure line (TG4) adapter to 67 in-lb. If adapter did not move, proceed to next step. If adapter moved, remove and replace adapter and seal, and torque adapter to 67-73 in-lb.

t. Remove protective material and weld oxidizer turbine exhaust pressure line (TG4). (Refer to section VI for tube welding requirements.)

u. Connect electrical connector (paragraph 3-31) P128.

v. Disassemble track. (Refer to section V.)

w. Install hydraulic pump using Stage Contractor procedures.

x. Refer to section IV for test requirements.

3-127. <u>HEAT EXCHANGER ANTIFLOOD CHECK VALVE.</u>

3-128. REMOVING HEAT EXCHANGER ANTIFLOOD CHECK VALVE. (See figure 3-30.)

a. Obtain adapter T-5044632.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Cut oxidizer inlet pressure instrumentation line (HO1) at first straight section from valve instrumentation port. (Refer to section VI for tube cutting requirements.) Protect open lines.

d. Remove bolts, washers, and brackets that secure oxidizer inlet line to oxidizer pump discharge duct. Remove seal and protect open ports and sealing surfaces.

e. Remove nuts, screws, washers, and clamps that secure oxidizer inlet line to thrust chamber. Support weight of oxidizer inlet line.

eA. Remove bolts and washers that secure bypass line to antiflood check valve. Remove seal and protect open ports and sealing surfaces.

eB. Using adapter T-5044632, remove bolts and washers that secure antiflood check valve to heat exchanger. Remove seal; then remove antiflood check valve and oxidizer inlet line.

f. Remove protective material from ports, sealing surfaces, and line ends, and install clean protective closures (paragraph 3-258).

3-129. INSTALLING HEAT EXCHANGER ANTIFLOOD CHECK VALVE. (See figure 3-30.)

a. Obtain adapter T-5044632.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure mating connections on bypass line, antiflood check valve, oxidizer inlet line, oxidizer pump discharge duct, and heat exchanger are clean and free of damage, and threads in parent metal and/or threaded inserts are free of damage and installed correctly (section I). Protect open ports and sealing surfaces.

d. Make sure antiflood check valve and oxidizer inlet line are clean, free of damage, and OK to install.

e. Remove protective material from mating flanges of heat exchanger and antiflood check valve; and install seal, antiflood check valve, and oxidizer inlet line as a unit, on heat exchanger with washers and bolts. Using adapter T-5044632, cross-torque bolts to 100 ±5 in-lb and safetywire.

eA. Remove protective material from mating flanges of oxidizer inlet line and oxidizer pump discharge duct, and install seal, brackets, and oxidizer inlet line on oxidizer pump discharge duct with washers and bolts. Torque bolts to 48-53 in-lb and safetywire.

f. Make sure attach hole in line support clamp, adjacent to flexible section of oxidizer inlet line, alines with attach hole in its mounting bracket within one-half hole; and then install clamps, screws, washers, and nuts that secure oxidizer inlet line to thrust chamber. Torque screws to 24-30 in-lb. If attach hole is not within one-half hole, contact Engine Contractor.

g. Remove protective material from mating flanges of bypass line and antiflood check valve, and install seal and bypass line on antiflood check valve with washers and bolts. Torque bolts to 48-53 in-lb and safetywire.

h. Torque oxidizer inlet pressure instrumentation line (HO1) adapter to 67 in-lb. If adapter tube stub alines with existing line, proceed to next step. If adapter tube stub does not aline with existing line, remove and replace adapter and seal, and torque adapter to 67-73 in-lb.

i. Remove protective material from cut ends of oxidizer inlet pressure instrumentation line (HO1) and weld line. (Refer to section VI for welding requirements.)

j. Refer to section IV for test requirements.

3-130. HEAT EXCHANGER INLET MANIFOLD FILTER AND ORIFICES.

3-131. REMOVING HEAT EXCHANGER INLET MANIFOLD FILTER AND ORIFICES (ENGINES INCORPORATING MD363 CHANGE).

a. Obtain the following:

(1) Adapter T-5044632

(2) Tool T-5047359 (required only if filter retaining stud measurements change during filter removal)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I, and do the following:

(1) Make sure all pressure has vented upstream and downstream of antiflood check valve. (See figure 3-30.)

(2) Cut oxidizer inlet pressure instrumentation line (HO1) at first straight section from valve instrumentation port. (Refer to section VI for tube cutting requirements.) Protect open lines.

(3) Remove bolts and washers that secure bypass line to antiflood check valve. Remove seal, and protect open ports and sealing surfaces.

(4) Remove clamps supporting oxidizer inlet line between thrust chamber and antiflood check valve.

(5) Using adapter T-5044632, remove bolts and washers that secure antiflood check valve to heat exchanger. Remove seal, and protect open ports and sealing surfaces. Move antiflood check valve until flanges just clear each other; then tie antiflood check valve securely in this position.

c. If engine is in a position where filter nut is lower than orifice plates, proceed to step f.

d. With engine in a position where filter nut is higher than orifice plates, do the following: (See figure 3-31.)

(1) Measure from heat exchanger inlet manifold flange to end of filter stud, and record as measurement No. 1.

(2) Remove filter nut and filter, repeat substep 1, and record as measurement No. 2.

(3) Remove, package, and retain orifice plates for reinstallation.

(4) If difference in measurements recorded in substeps 1 and 2 is 1/32 inch or less, proceed to step h.

WARNING

The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

CAUTION

The following procedure requires staking of the filter retaining stud using an automatic center punch and special staking tool. The staking tool should be torqued adequately into the center punch to prevent thread damage to the tools.

(5) If difference in measurements recorded in substeps 1 and 2 is greater than 1/32 inch, install 4 plugs from tool T-5047359 in heat exchanger coil openings; then measure length of stud from bottom of heat exchanger inlet manifold. Adjust stud as required to extend 0.470 to 0.620 inch. Do not exceed 15 in-lb torque. Protect heat exchanger inlet manifold flange and stud (figure 3-31) using components of tool T-5047359. Adjust automatic center punch to highest impact and stake 25 times each at any 3 of the 4 points at base of stud and 90 degrees apart. (See figure 3-31.) Remove protective components of tool T-5047359 from heat exchanger inlet manifold flange and stud. Vacuum heat exchanger inlet manifold port and remove 4 plugs from heat exchanger coil openings. With a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602), cleaning compound (MIL-C-81302), or trichloroethane (MIL-T-81533), wipe heat exchanger inlet manifold port, and make sure there are no foreign particles visible.

e. Proceed to step h.

CAUTION

When engine is in a position where filter nut is lower than orifice plates, orifice plates will fall from heat exchanger as the filter is removed.

f. With engine in a position where filter nut is lower than orifice plates, hold vinyl sheet under heat exchanger inlet manifold to catch parts or tools that may be accidentally dropped, and do the following: (See figure 3-31.)

(1) Measure from heat exchanger inlet manifold flange to end of filter stud, and record as measurement No. 1.

(2) Hold filter and remove filter nut.

(3) Remove filter, allowing orifice plates to fall into vinyl sheet. Package and retain orifice plates for reinstallation.

(4) Repeat substep 1, and record as measurement No. 2.

g. If difference in measurements recorded in step f, substeps 1 and 4 is 1/32 inch or less, proceed to step h. If difference in measurements recorded in step f, substeps 1 and 4 is greater than 1/32 inch, proceed as follows:

(1) Measure length of filter stud from bottom of heat exchanger inlet manifold.

CAUTION

Excessive torque applied to the heat exchanger inlet filter retaining stud can cause failure of the stud. Torque must not exceed 15 in-lb.

(2) Adjust stud as required to extend 0.470 to 0.620 inch. Do not exceed 15 in-lb torque.

(3) Protect heat exchanger inlet manifold flange and stud (figure 3-31) using components of tool T-5047359.

CAUTION

The following procedure requires staking of the filter retaining stud using an automatic center punch and special staking tool. The staking tool should be torqued adequately into the center punch to prevent thread damage to the tools.

(4) Adjust automatic center punch to highest impact and stake 25 times each at any 3 of the 4 points at base of stud and 90 degrees apart. (See figure 3-31.)

WARNING

The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

(5) With a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602), cleaning compound (MIL-C-81302), or trichloroethane (MIL-T-81533), wipe heat exchanger inlet manifold port, and make sure there are no foreign particles visible.

h. Remove protective material from ports, sealing surfaces, and line ends and install clean protective closures (paragraph 3-258).

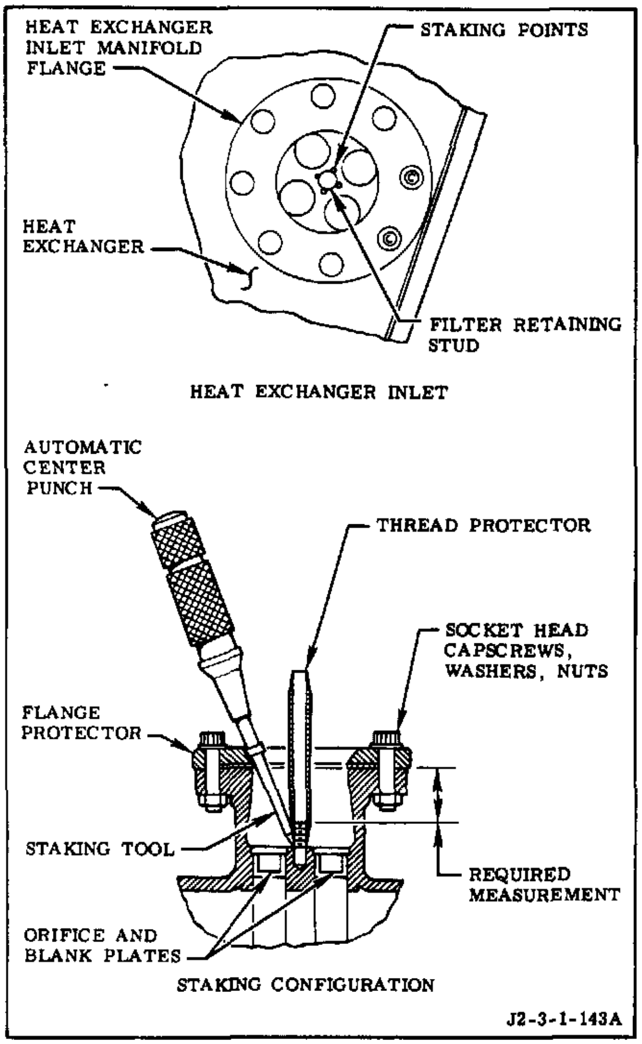


Figure 3-31. Staking Filter Retaining Stud

3-132. REMOVING HEAT EXCHANGER INLET MANIFOLD FILTER AND ORIFICE (ENGINES INCORPORATING MD375 CHANGE). (See figure 3-31A.)

a. Obtain the following:

(1) Adapter T-5044632

(2) Tool T-5047359 (required only if filter retaining stud measurements change during filter removal)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure all pressure has vented upstream and downstream of antiflood check valve. (See figure 3-30.)

d. Cut oxidizer inlet pressure instrumentation line (HO1) at first straight section from valve instrumentation port. (Refer to section VI for tube cutting requirements.) Protect open lines.

e. Remove bolts and washers that secure bypass line to antiflood check valve. Remove seal, and protect open ports and sealing surfaces.

f. Remove clamps supporting oxidizer inlet line between thrust chamber and antiflood check valve.

g. Using adapter T-5044632, remove bolts and washers that secure antiflood check valve to heat exchanger. Remove seal, and protect open ports and sealing surfaces. Move antiflood check valve until flanges just clear each other; then tie antiflood check valve securely in this position.

h. Using a 3/16-inch internal wrenching hex adapter, remove filter. (See figure 3-31A.)

i. If heat exchanger inlet manifold orifices and blank plates are to be removed, proceed to step j. If orifices and blank plates are not to be removed, proceed to step n.

j. If engine is in a position where retainer and nut are lower than orifice plates, proceed to step 1.

k. With engine in a position where retainer and nut are higher than orifice plates, do the following: (See figure 3-31.)

(1) Measure from heat exchanger inlet manifold flange to end of filter stud, and record as measurement No. 1.

(2) Remove retainer nut and retainer, repeat substep 1, and record as measurement No. 2.

(2A) Remove, package, and retain orifice plates for reinstallation.

(3) If difference in measurements recorded in substeps 1 and 2 is 1/32 inch or less, proceed to step n.

WARNING

The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

CAUTION

The following procedure requires staking of the filter retaining stud using an automatic center punch and special staking tool. The staking tool should be torqued adequately into the center punch to prevent thread damage to the tools.

(4) If difference in measurements recorded in substeps 1 and 2 is greater than 1/32 inch, install 4 plugs from tool T-5047359 in heat exchanger coil openings; then measure length of stud from bottom of heat exchanger inlet manifold. Adjust stud as required to extend 0.470 to 0.620 inch. Do not exceed 15 in-lb torque. Protect heat exchanger inlet manifold flange and stud (figure 3-31) using components of tool T-5047359. Adjust automatic center punch to highest impact and stake 25 times each at any 3 of the 4 points at base of stud and 90 degrees apart. (See figure 3-31.) Remove protective components of tool T-5047359 from heat exchanger inlet manifold flange and stud. Vacuum heat exchanger inlet manifold port and remove 4 plugs from heat exchanger coil openings. With a clean, lint-free cloth dampened with trichloroethylene (MIL-T-27602), cleaning compound (MIL-C-81302), or trichloroethane (MIL-T-81533), wipe heat exchanger inlet manifold port, and make sure there are no foreign particles visible. Proceed to step n.

CAUTION

When engine is in a position where retainer and nut are lower than orifice plates, orifice plates will fall from heat exchanger as the retainer is removed.

l. With engine in a position where orifice retainer nut is lower than orifice plates, hold vinyl sheet under heat exchanger inlet manifold to catch parts or tools that may be accidentally dropped, and do the following:

(1) Measure from heat exchanger inlet manifold flange to end of filter stud, and record as measurement No. 1.

(2) Hold orifice retainer and remove orifice retainer nut.

(3) Remove orifice retainer allowing orifice plates to fall into vinyl sheet. Package and retain orifice plates for reinstallation.

(4) Repeat substep 1, and record as measurement No. 2.

m. If difference in measurements recorded in step l, substeps 1 and 4 is 1/32 inch or less, proceed to step n. If difference in measurements recorded in step l, substeps 1 and 4 is greater than 1/32 inch, proceed as follows:

(1) Measure length of filter stud from bottom of heat exchanger inlet manifold.

CAUTION

Excessive torque applied to the heat exchanger inlet filter retaining stud can cause failure of the stud. Torque must not exceed 15 in-lb.

(2) Adjust stud as required to extend 0.470 to 0.620 inch. Do not exceed 15 in-lb torque.

(3) Protect heat exchanger inlet manifold flange and stud (figure 3-31) using components of tool T-5047359.

(4) Adjust automatic center punch to highest impact and stake 25 times each at any 3 of the 4 points at base of stud and 90 degrees apart. (See figure 3-31.)

WARNING

The following procedure specifies trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

(5) With a clean, lint-free cloth dampened in trichloroethylene (MIL-T-27602), cleaning compound (MIL-C-81302), or trichloroethane (MIL-T-81533), wipe heat exchanger inlet manifold port, and make sure there are no foreign particles visible.

n. Remove protective material from ports, sealing surfaces, and line ends and install clean protective closures (paragraph 3-258).

3-132A. INSTALLING HEAT EXCHANGER INLET MANIFOLD FILTER AND ORIFICE (ENGINES INCORPORATING MD375 CHANGE). (See figure 3-31A.)

a. Obtain adapter T-5044632.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257).

d. Make sure heat exchanger inlet manifold and filter are clean and free of damage.

e. If heat exchanger inlet manifold orifice and blank plates were not removed, disregard steps f through m and proceed to step n.

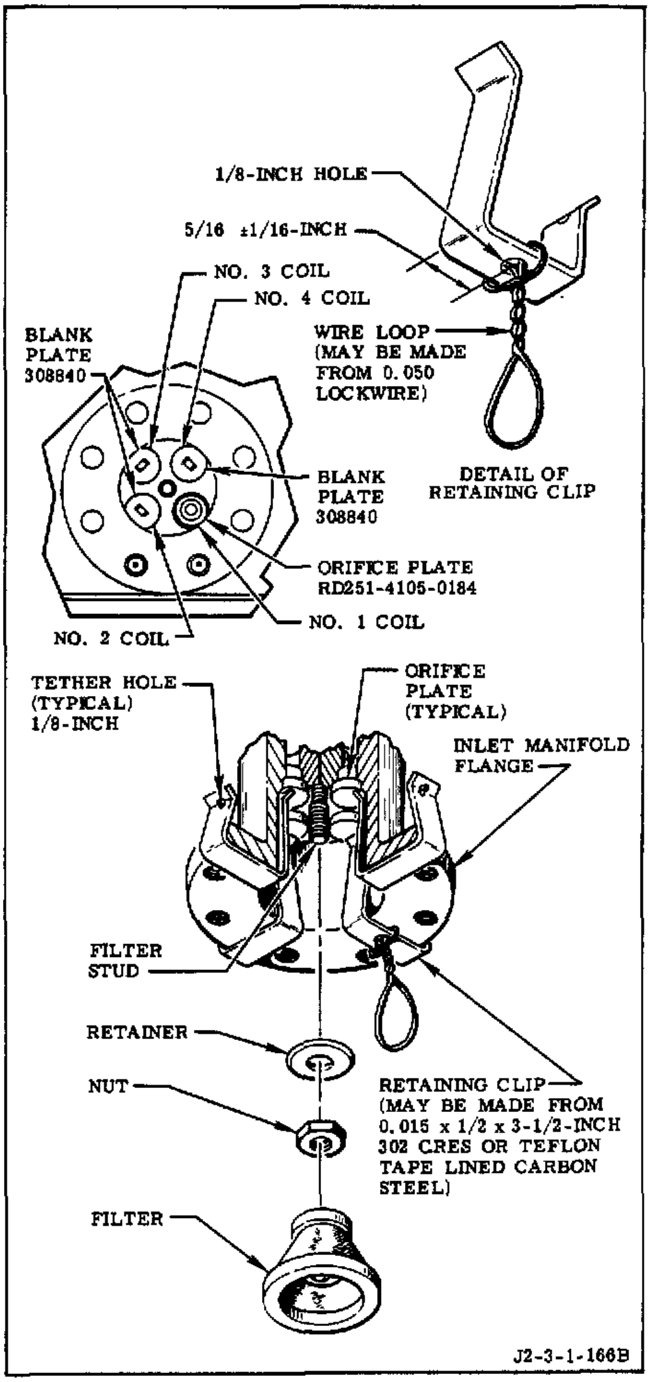


Figure 3-31A. Installing Orifices, Blank Plates, and Filter (Engines Incorporating MD375 Change)

f. If engine is in a position where manifold flange is lower than orifice plate locations, proceed to step i.

g. If engine is in a position where manifold flange is higher than orifice plate locations, install orifice and blank plates in correct location. (See figure 3-31A for locations.)

h. Install retainer on filter retaining stud and secure with nut. Proceed to step l.

i. Hold vinyl sheet under heat exchanger inlet manifold to catch any items that might be accidentally dropped.

j. Tether retaining clips together and to inlet manifold.

k. Install orifice and blank plates in correct location as follows: (See figure 3-31A for locations.)

(1) Snap retaining clip on inlet manifold flange.

(2) Insert orifice or blank plate in correct location.

(3) Slide retaining clip into position so that plate is held in place.

(4) Repeat substep 1 through 3 until orifice and 3 blank plates are installed.

(5) Install retainer on filter retaining stud and secure with nut.

CAUTION

Excessive torque applied to the orifice retaining nut can cause failure of the filter retaining stud. Torque must not exceed 15 in-lb.

l. Make sure orifice and blank plates are in position and torque retaining nut to 12-15 in-lb.

m. Remove retaining clips from inlet manifold flange.

CAUTION

Excessive torque applied to the heat exchanger inlet filter can cause failure of the filter retaining stud. Torque must not exceed 15 in-lb.

n. Install filter on filter retaining stud and using 1/8-inch hex adapter, torque filter to 12-15 in-lb.

o. Measure radial gap between rim of inlet filter and heat exchanger inlet flange. If gap exceeds 0.078 inch, contact local Rocketdyne Representative for disposition.

p. Install antiflood check valve as follows: (See figure 3-30.)

(1) Remove protective closures (paragraph 3-257). Make sure mating connections on bypass line, antiflood check valve, heat exchanger, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

(2) Remove protective material from mating flanges of heat exchanger and antiflood check valve.

(3) Make sure antiflood check valve is clean, free of damage, and OK to install.

(4) Install seal and antiflood check valve and oxidizer inlet line, as a unit, on heat exchanger with washers and bolts. Using adapter T-5044632, cross-torque bolts to 100 ±5 in-lb and safetywire.

(5) Make sure attach hole in line support clamp, adjacent to flexible section of oxidizer inlet line, alines with attach hole in its mounting bracket within one-half hole; then install clamps, screws, washers, and nuts that secure oxidizer inlet line to thrust chamber. Torque screws to 24-30 in-lb. If attach hole is not within one-half hole, contact local Rocketdyne Representative.

(6) Remove protective material from mating flanges of bypass line and antiflood check valve, and install seal and bypass line on antiflood check valve with washers and bolts. Torque bolts to 50 ±3 in-lb and safetywire.

(7) Torque oxidizer inlet pressure instrumentation line (HO1) adapter to 67 in-lb. If adapter tube stub alines with existing line, proceed to next step. If adapter tube stub does not aline with existing line, remove and replace adapter and seal, and torque adapter to 67-73 in-lb.

(8) Remove protective material from cut ends of oxidizer inlet pressure instrumentation line (HO1), and weld line. (Refer to section VI for welding requirements.)

q. Refer to section IV for test requirements.

3-133. HEAT EXCHANGER OXIDIZER OUTLET, OXIDIZER TURBOPUMP DISCHARGE, HELIUM TANK GAS, AND START TANK GAS TEMPERATURE TRANSDUCERS.

3-134. REMOVING HEAT EXCHANGER OXIDIZER OUTLET, OXIDIZER TURBOPUMP DISCHARGE, HELIUM TANK GAS, AND START TANK GAS TEMPERATURE TRANSDUCERS. (See figure 3-32.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

NOTE

Parts indexed in the following procedure are illustrated in figure 3-32.

b. Disconnect electrical connector (6). (Refer to paragraph 3-30.)

c. Remove bolts (5), washers (4), lug (3), transducer (2), and seal (1).

d. Install clean protective closures (paragraph 3-258) on transducer and open port on engine.

3-135. INSTALLING HEAT EXCHANGER OXIDIZER OUTLET, OXIDIZER TURBOPUMP DISCHARGE, HELIUM TANK GAS, AND START TANK GAS TEMPERATURE TRANSDUCERS. (See figure 3-32.)

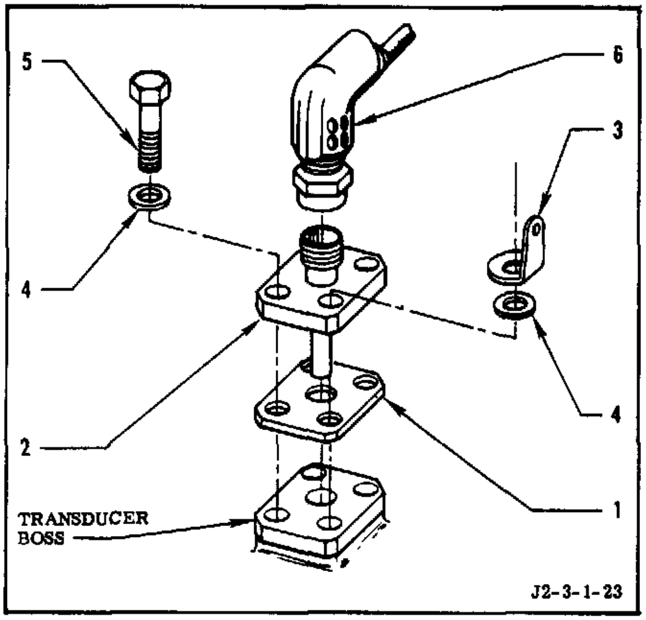
a. If transducer is being replaced, verify that temperature transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from engine port. Make sure engine port, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

c. Remove protective closure (paragraph 3-257) from transducer.

d. Wipe transducer and boss sealing surfaces with a clean, lint-free cloth, and make sure sealing surfaces are free of nicks, scratches, deposits, or other imperfections that would impair sealing.



Index Number	Description
1	Seal
2	Temperature transducer
3	Lug
4	Washer
5	Bolt
6	Electrical connector

Figure 3-32. Heat Exchanger Oxidizer Outlet, Oxidizer Turbopump Discharge, Helium Tank Gas, and Start Tank Gas Temperature Transducers

e. Install plate seal (1) over stem of transducer (2); insert and position transducer in boss to aline transducer connector key with electrical connector (6) keyway: then install washers (4), lug (3), and bolts (5).

f. Cross-torque bolts (5) to 48-53 in-lb and safetywire.

g. Connect electrical connector (paragraph 3-31) (6) to transducer (2), and install support clamps on harness.

h. Refer to section IV for test requirements.

3-136. HELIUM COVER AND HELIUM FILL-CHECK VALVE.

3-137. REMOVING HELIUM COVER AND HELIUM FILL-CHECK VALVE. (See figure 3-33.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove integral hydrogen-helium start tank (paragraph 3-170).

c. Disconnect electrical connector (paragraph 3-30) P122.

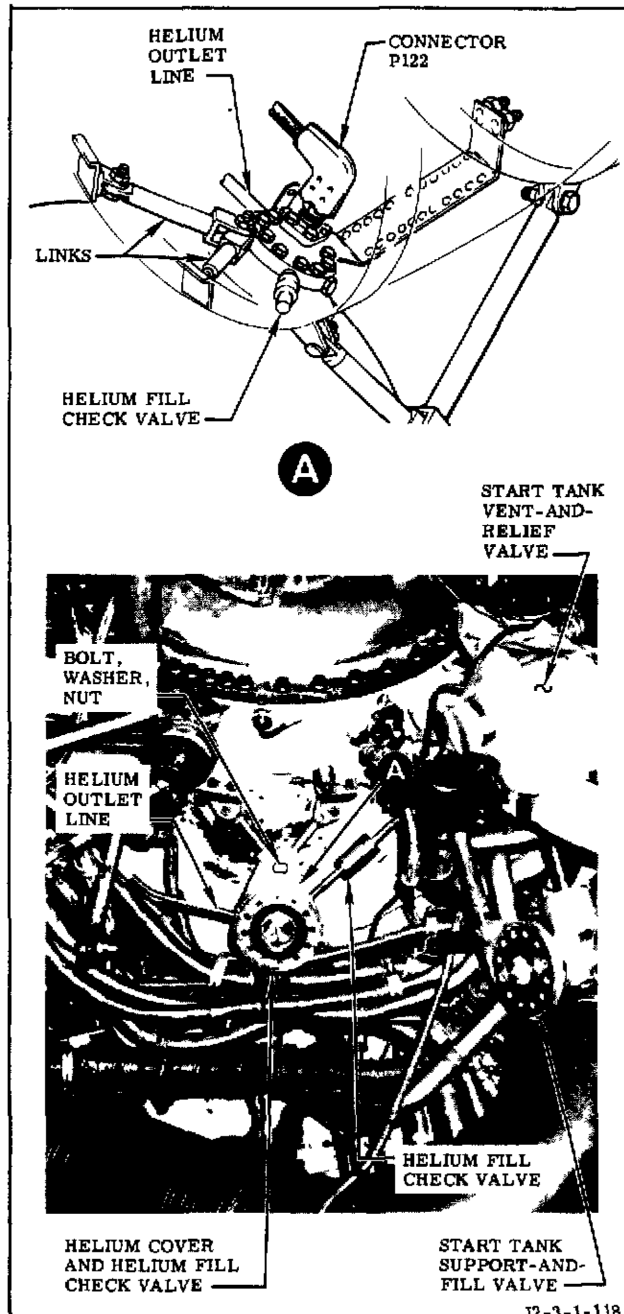


Figure 3-33. Helium Cover and Helium Fill-Check Valve

d. Cut helium outlet line and helium fill line. (Cut helium fill line upstream of check valve. Refer to section VI for tube cutting requirements.) Protect open ends of cut lines.

e. Remove nut, bolt, and washers that secure helium cover and fill-check valve to links. Install protective closure (paragraph 3-258) on helium cover and fill-check valve, and protect temperature probe.

3-138. INSTALLING HELIUM COVER AND HELIUM FILL-CHECK VALVE. (See figure 3-33.)

a. If check valve is being replaced, verify that helium fill-check valve preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from helium cover and fill-check valve and mating connection of start tank. Make sure helium cover and fill-check valve and mating connection of start tank, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

c. Install bolt, nut, and washers that secure helium cover and helium fill-check valve to links. Run nut on bolt threads until washers bottom against shoulder of bolt.

d. Remove protective material from weld helium outlet line and helium fill line, and weld tubes. (Refer to section VI for tube welding requirements.)

e. Connect electrical connector (paragraph 3-31) P122.

f. Install integral hydrogen-helium start tank (paragraph 3-170).

g. Refer to section IV for test requirements.

3-139. HELIUM CONTROL VALVE.

3-140. REMOVING HELIUM CONTROL VALVE. (See figure 3-34.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (paragraph 3-30) P13 (1).

c. Install polyethylene (or equivalent) sheet of suitable size and thickness directly below helium control valve to catch any parts that may be dropped.

CAUTION

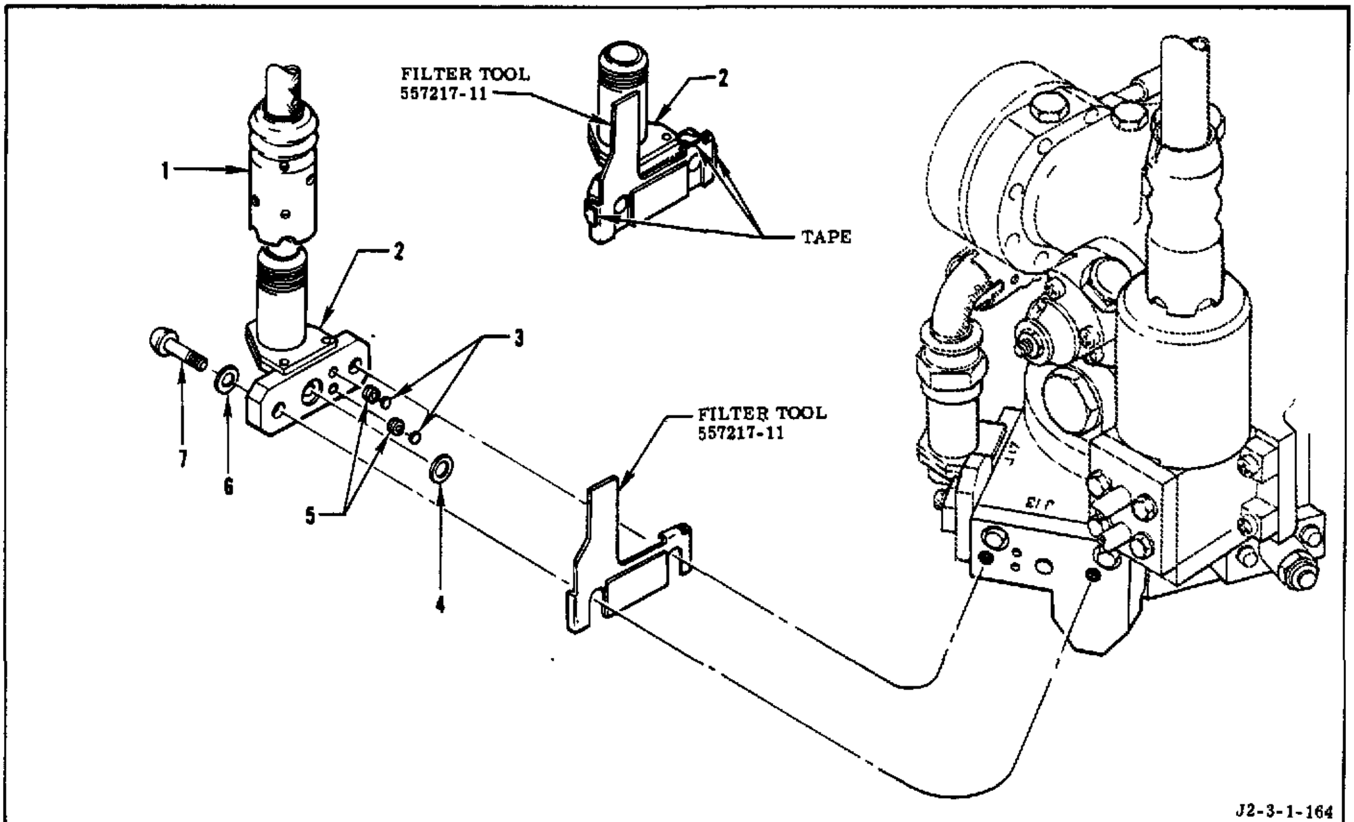
Care must be taken when separating the helium control valve from its mating surface since the seals and orifices can fall out when separation occurs and may be damaged or lost. If the orifices or seals are missing from the control valve, the mating surface should be examined. Adhesion may have held the orifices or seals to the flat surface.

d. Remove bolts (7), washers (6), helium control valve (2), orifices (3), and seals (4, 5).

NOTE

The clamps on the pneumatic lines adjacent to the helium control valve may be removed to increase access to the control valve mounting bolts. Note location of the clamps before removal to aid in correct reinstallation.

e. Install clean protective closures (paragraph 3-258) on all open ports and orifices.



Index No.	Description	Index No.	Description
1	Electrical connector P13	5	Seal
2	Helium control valve	6	Washer
3	Orifice	7	Bolt
4	Seal		

Figure 3-34. Helium Control Valve

3-141. INSTALLING HELIUM CONTROL VALVE. (See figure 3-34.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. On engines incorporating MD372 change, make sure helium control valve filter (paragraph 3-141A) is installed.

c. Obtain filter tool 557217-11.

d. Make sure tape on filter tool is not damaged and is free of any impressions indicating previous use. If tape is damaged or contains impressions, replace tape. Use P421 Teflon tape (Johnson and Johnson, Inc), or equivalent.

e. Remove protective material from helium control valve (2) and surfaces that mate to helium control valve.

f. Make sure control valve (2) and mating connection are clean and free of damage, and threaded inserts are installed correctly (section I).

g. Make sure sealing surfaces, ports, and all components are clean and free of damage. If tape on orifices is wrinkled or loose, replace orifices.

h. Install seals (4, 5) in helium control valve (2); then insert orifices (3) into seals.

NOTE

The seals should fit into the recesses of the valve without the use of force. Seals that do not fit readily into recesses must not be used.

i. Hold seals and orifices in valve recesses using filter tool. Use pressure-sensitive tape (Federal Specification PPP-T-60), or equivalent, and tape filter tool to helium control valve. Do not apply tape to surface that will contact mating surfaces.

NOTE

The filter tool may be gently hand-formed (to provide a convexed shape), in the area of the pressure-sensitive tape, to apply additional pressure on the seals when the tool is taped on the control valve.

j. Attach control valve (2), with orifices and seals, with bolts (7) and washers (6). Torque bolts to 24-26 in-lb.

k. Remove tape that secures filter tool to control valve.

l. While applying a slight pressure on control valve (2) in direction of helium regulator, loosen bolts (7) approximately 1/4 turn, carefully remove filter tool, and retorque bolts to 24-26 in-lb.

m. Check impressions on Teflon tape on filter tool to make sure seals (4, 5) are correctly positioned. If tape does not have a circular impression of each of the 3 seals or if tape is cut or torn, remove seals, orifices, and control valve and reinstall as outlined in steps d and f through m.

n. Cross-torque (section I) bolts (7) to 72-88 in-lb.

o. Install any line support clamps that were removed to gain access to helium control valve. Torque screws to 24-30 in-lb.

p. Connect electrical connector (paragraph 3-31) P13 (1).

q. Remove polyethylene (or equivalent) sheet from below helium control valve.

3-141A. HELIUM CONTROL VALVE FILTER (ENGINES INCORPORATING MD372 CHANGE).

3-141B. REMOVING HELIUM CONTROL VALVE FILTER. (See figure 3-34A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

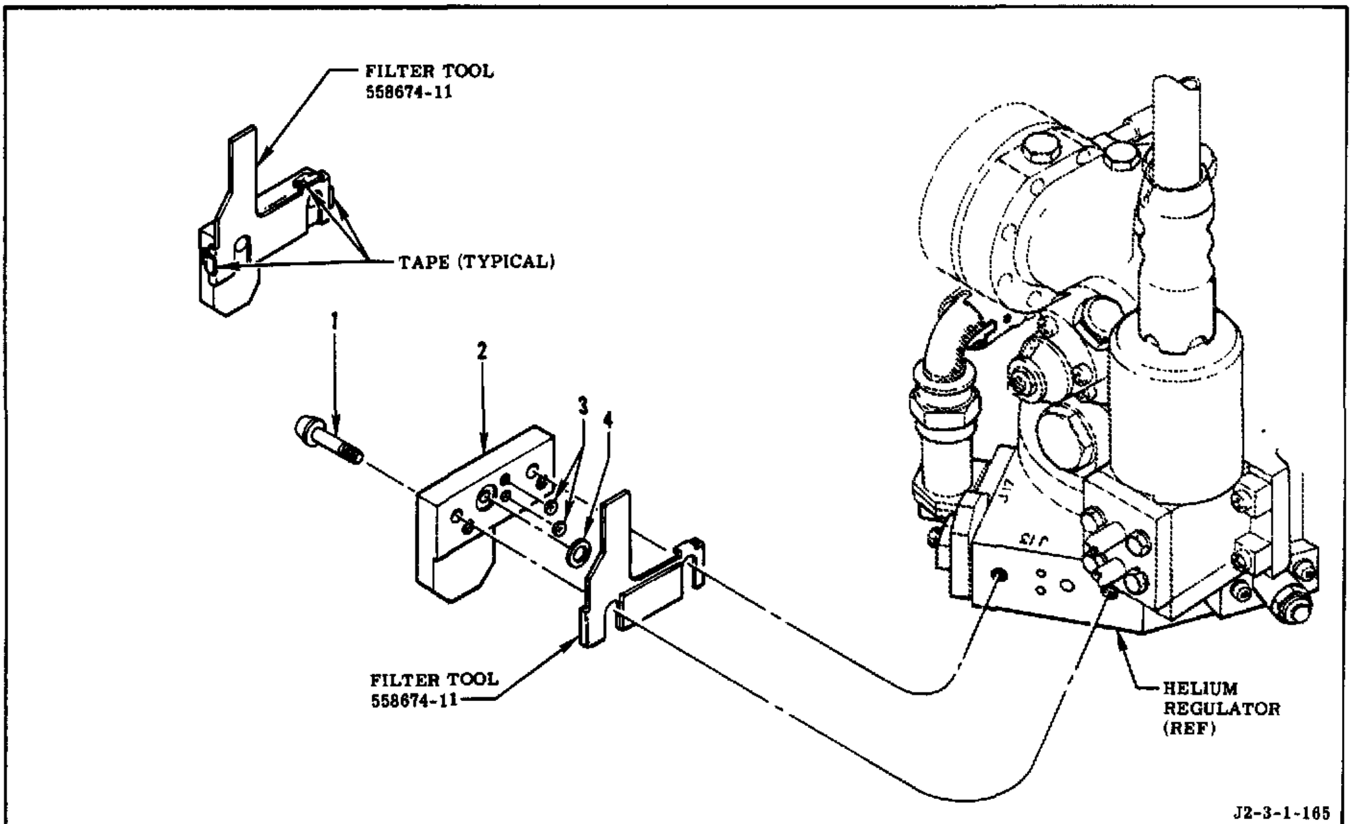
b. Remove helium control valve (paragraph 3-140).

CAUTION

Care must be taken when separating filter from helium regulator since the seals can fall out when separation occurs and may be damaged or lost. If seals are missing from filter, the mating surface should be examined. Adhesion may have held the seals fixed to the flat surfaces.

c. Remove bolts (1), filter (2), and seals (3, 4). Make sure not to drop seals when separating filter from regulator.

d. Install clean protective closures (paragraph 3-258) on all open ports.



Index No.	Description	Index No.	Description
1	Bolt	3	Seal
2	Helium control valve filter	4	Seal

Figure 3-34A. Helium Control Valve Filter

3-141C. INSTALLING HELIUM CONTROL VALVE FILTER. (See figure 3-34A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Obtain filter tool 558674-11.

c. Make sure tape on filter tool is not damaged and is free of any impressions indicating previous use. If tape is damaged or contains impressions, replace tape. Use P421 Teflon tape (Johnson and Johnson, Inc), or equivalent.

d. Remove protective material from filter (2) and mating surfaces on helium regulator.

e. Make sure filter, mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

f. Make sure sealing surfaces, ports, and all components are clean and free of damage.

g. Install a strip of Aclar No. 33C film (Allied Chemical Corp), or equivalent, to cover sealing surfaces on filter (control valve mating surface), to protect against damage during installation. Material may be held in position with pressure-sensitive tape (Federal Specification PPP-T-60), or equivalent. Do not apply tape to sealing surfaces.

h. Install seals (3, 4) in filter (2).

NOTE

The seals should fit into the recesses of the filter without the use of force. Seals that do not fit readily into the recesses must not be used.

i. Hold seals (3, 4) in position using filter tool. Use pressure-sensitive tape (Federal Specification PPP-T-60), or equivalent, and tape filter tool to filter (2). Do not apply tape to surfaces that will come in contact with helium regulator.

NOTE

The filter tool may be gently handformed (to provide a convexed shape), in the area of the pressure-sensitive tape, to apply additional pressure on the seals when the tool is taped on the filter.

j. Install filter, with seals installed in step h, on helium regulator with bolts (1). Torque bolts to 24-26 in-lb.

NOTE

To help position filter on helium regulator, pencil marks may be placed on helium regulator dome to indicate centerlines of attachment bolt taps. When installed, one end of the filter will be flush with the corner of the helium regulator dome.

- Using an 18-inch extension and positioning the torque wrench below and outside of the oxidizer high-pressure duct will make torquing easier.

k. Remove tape that secures filter tool to filter.

l. While applying a slight pressure on filter (2) in direction of helium regulator, loosen bolts (1) approximately 1/4 turn, carefully remove filter tool, and retorque bolts to 24-26 in-lb.

m. Check impressions on Teflon tape on filter tool to make sure seals (3, 4) are correctly positioned. If tape does not have a circular impression of each of the 3 seals or if tape is cut or torn, remove seals and filter and reinstall as outlined in steps c and e through m.

n. Cross-torque (section I) bolts (1) to 72-88 in-lb. (If bolts with drilled heads are installed, do not safetywire.)

o. Refer to section IV for test requirements.

3-142. HELIUM REGULATOR ASSEMBLY (PNEUMATIC CONTROL PACKAGE).

3-143. REMOVING HELIUM REGULATOR ASSEMBLY (PNEUMATIC CONTROL PACKAGE). (See figure 3-35.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical control assembly (ECA) support rod from ECA, and pivot ECA back until it rests on thrust chamber.

c. Remove support clamps, as necessary, to gain access to regulator. Note position of clamps for reinstallation.

d. Make sure electrical power to engine is off; then disconnect the following electrical connectors: (Refer to paragraph 3-30.)

(1) P13

(2) P14

(3) P15

(4) P17

(5) P111

(6) P120

e. Make sure pneumatic control system is depressurized.

f. Cut bleed valve control line and outlet pressure line (NN2). Cut outlet pressure line on each side of tee and remove a section of line including tee. (Refer to section VI for tube cutting requirements.) Protect open lines.

g. Remove bolts and washers that secure accumulator hose to regulator, and remove seal.

h. Remove bolts and washers that secure ignition control manifold to regulator, and remove seal.

i. Remove bolts and washers that secure mainstage control manifold to regulator, and remove seal.

j. Remove bolts and washers that secure cover to regulator, and remove seal.

CAUTION

Extreme care must be used when removing the helium regulator assembly from the engine, to prevent damage to the regulator and adjacent components.

k. Remove bolts, washers, and nuts that secure regulator mounting bracket to thrust chamber manifold. Carefully remove helium regulator assembly from engine.

l. Remove nuts, bolts, and washers that secure mounting bracket to helium regulator. Retain nuts, bolts, washers, and mounting bracket for reinstallation.

m. If helium regulator assembly is to be replaced, remove and retain outlet pressure line adapter (port NN2) from old regulator for installation on new regulator.

n. Install clean protective closures (paragraph 3-258).

3-144. INSTALLING HELIUM REGULATOR ASSEMBLY (PNEUMATIC CONTROL PACKAGE). (See figure 3-35.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure regulator, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Install mounting bracket on helium regulator with nuts, bolts, and washers. Torque bolts to 57-63 in-lb and safetywire.

d. If helium regulator is being replaced, remove protective covering and install outlet pressure line adapter (removed from old regulator port NN2) and seal on new regulator. Torque adapter to 66-74 in-lb.

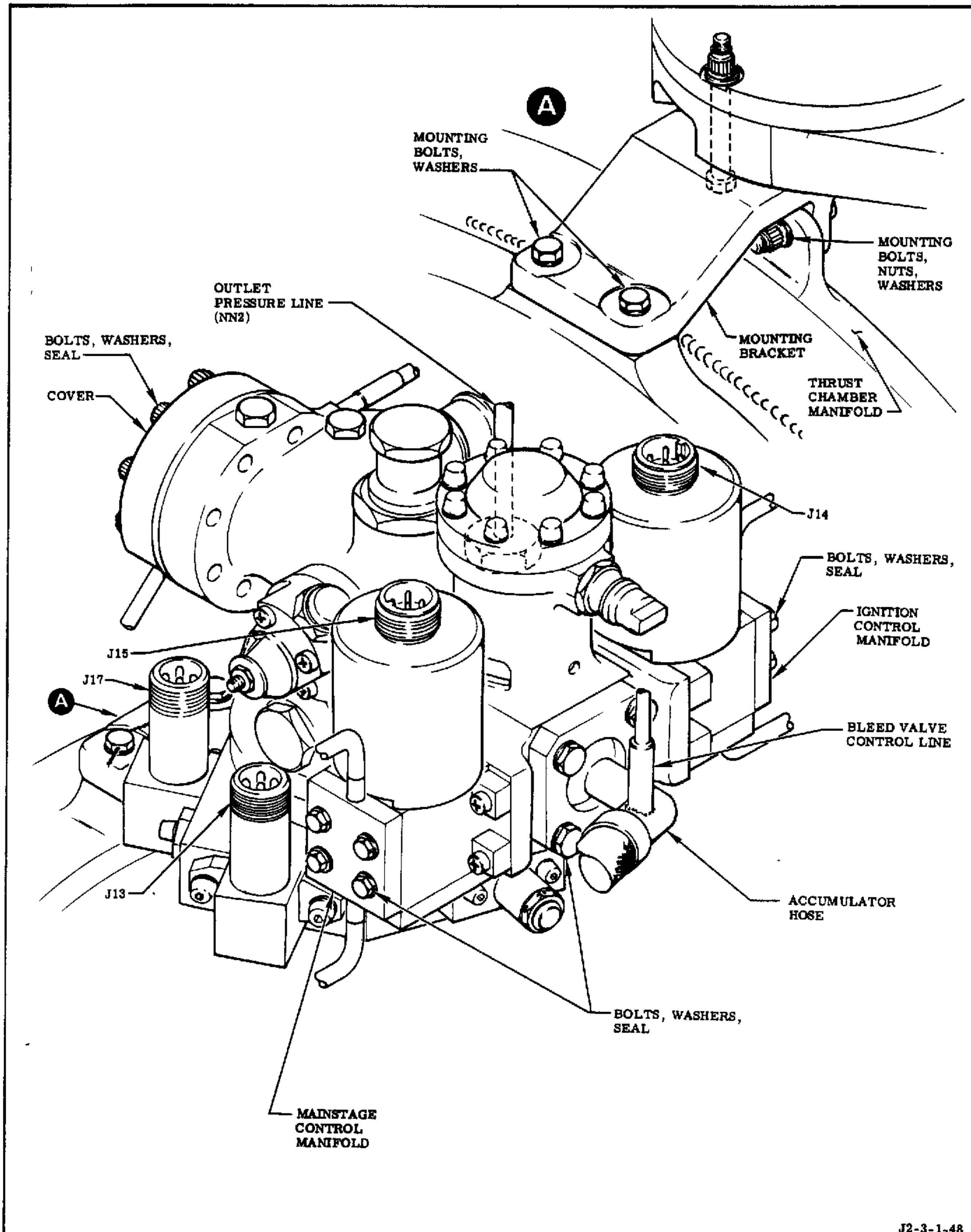


Figure 3-35. Helium Regulator Assembly (Pneumatic Control Package)

CAUTION

Extreme care must be used when installing the helium regulator assembly on the engine, to prevent damage to the regulator and adjacent components.

e. Remove protective covering; carefully install helium regulator on thrust chamber manifold and secure with bolts, washers, and nuts. Torque bolts to 57-63 in-lb and safetywire.

f. Remove protective covering, install seal, and secure cover to regulator with bolts and washers. Torque bolts to 72-78 in-lb and safetywire.

g. Weld outlet pressure line (NN2) in place. (Refer to section VI for tube welding requirements.) To provide weld head clearance it may be necessary to remove main regulator exhaust vent port check valve. Refer to paragraph 3-308 to remove vent port check valve.

gA. If removed, reinstall main regulator exhaust vent port check valve. (Refer to paragraph 3-309.)

h. Remove protective covering, install seal, and secure accumulator hose to regulator with bolts and washers. Torque bolts to 56-62 in-lb and safetywire.

i. Weld bleed valve control line in place. (Refer to section VI for tube welding requirements.)

j. Remove protective covering, install seal, and secure ignition control manifold to regulator with bolts and washers. Torque bolts to 26-28 in-lb and safetywire.

k. Remove protective covering, install seal, and secure mainstage control manifold to regulator with bolts and washers. Torque bolts to 26-28 in-lb and safetywire.

l. Make sure electrical power to engine is off; then connect the following electrical connectors: (Refer to paragraph 3-31.)

(1) P13

(2) P14

(3) P15

(4) P17

(5) P111

(6) P120

m. Pivot ECA into position and connect support rod to ECA with bolt, washer, spacer, and nut. Tighten nut until a 0.002-inch gap exists between nut and spacer.

n. Reinstall all support clamps to original location and position. Torque screws in support clamps to 24-30 in-lb.

o. On engines incorporating MD272 change, make sure rain-maze cover is installed on high-pressure relief valve.

p. Refer to section IV for test requirements.

3-144A. HELIUM TANK EMERGENCY VENT CONTROL VALVE.

3-144B. REMOVING HELIUM TANK EMERGENCY VENT CONTROL VALVE. (See figure 3-35A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (paragraph 3-30) P17 (1).

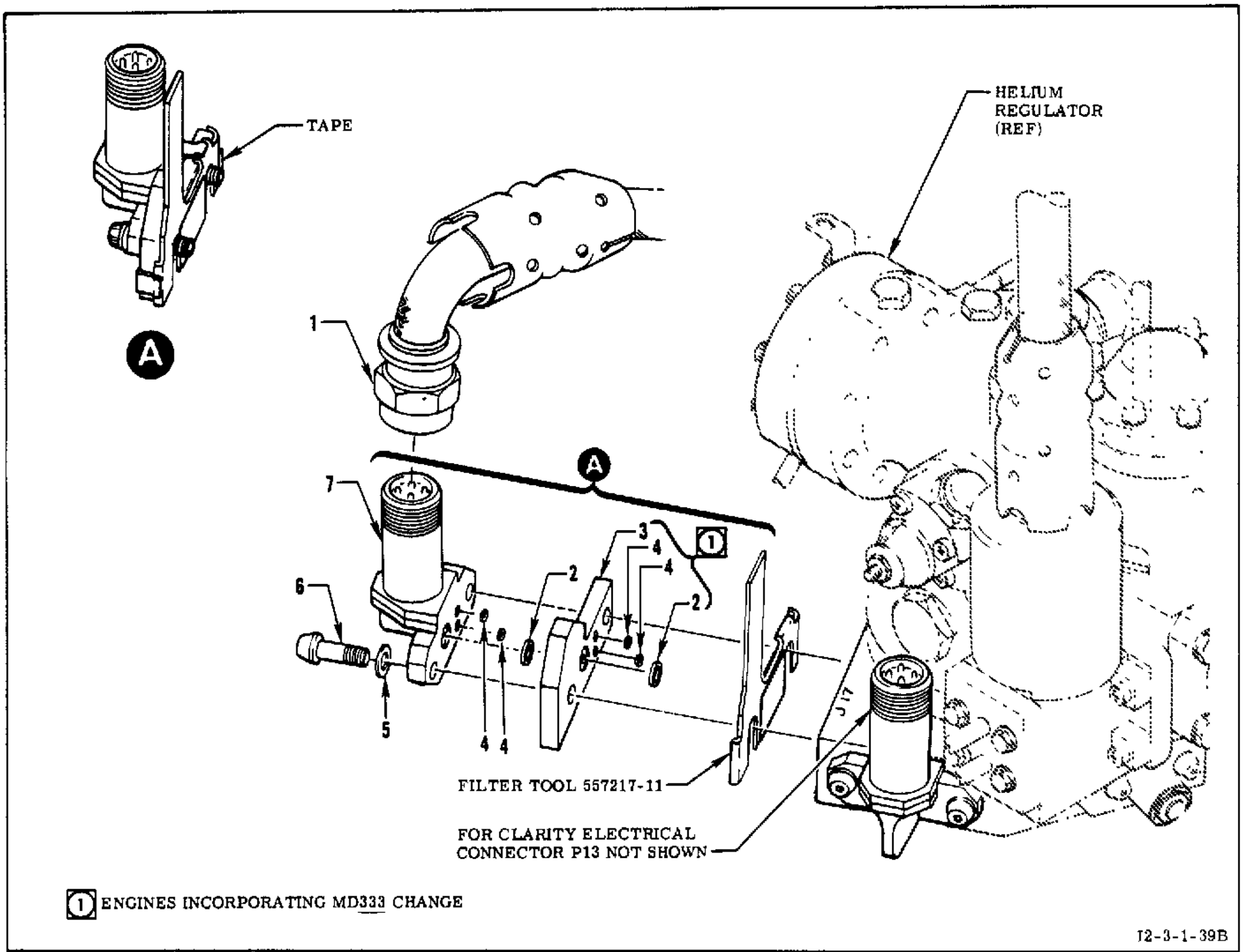
c. Install polyethylene (or equivalent) sheet of suitable size and thickness directly below helium tank emergency vent control valve to catch any parts that may be dropped.

CAUTION

Care must be taken when separating the control valve from the helium regulator since the filter and seals can fall out when separation occurs and may be damaged or lost. If seals are missing from the control valve or, on engines incorporating MD333 change, from the filter, the mating surface should be examined. Adhesion may have held the seals fixed to the flat surface.

- Engines not incorporating MD333 change do not have a filter and only the seals can fall out and be damaged or lost.

d. Remove bolts (6), washers (5), control valve (7), filter (3), and seals (2, 4). Engines not incorporating MD333 change do not have a filter and contain only one set of seals.



Index No.	Description	Index No.	Description
1	Electrical connector P17	5	Washer
2	Seal	6	Bolt
3	Filter	7	Helium tank emergency vent control valve
4	Seal		

Figure 3-35A. Helium Tank Emergency Vent Control Valve

NOTE

The clamps on the pneumatic lines adjacent to the helium tank emergency vent control valve may be removed to increase access to the control valve mounting bolts. Note location of the clamps before removal to aid in correct reinstallation.

e. Install clean protective closures (paragraph 3-258) on all open ports.

3-144C. INSTALLING HELIUM TANK EMERGENCY VENT CONTROL VALVE. (See figure 3-35A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Obtain filter tool 557217-11.

c. Make sure tape on filter tool is not damaged and is free of any impressions indicating previous use. If tape is damaged or contains impressions, replace tape. Use P421 Teflon tape (Johnson and Johnson, Inc), or equivalent.

d. Remove closures (paragraph 3-257) from valve and mating ports on helium regulator.

e. Make sure valve, mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

f. On engines incorporating MD333 change, remove protective material from filter (3).

g. Make sure filter sealing surfaces and ports are clean and free of damage.

NOTE

The seals should fit into the recesses of the valve, and on engines incorporating MD333 change, the filter (3) without the use of force. Seals that do not fit readily into the recesses must not be used.

h. Install seals (2, 4), washers (5), and bolts (6) on valve (7).

i. On engines incorporating MD333 change, install filter (3) on valve (7), and install seals (2, 4) on filter.

j. Hold seals in valve or in filter (engines incorporating MD333 change) using filter tool. Use pressure-sensitive tape (Federal Specification PPP-T-60), or equivalent, and tape filter tool to helium tank emergency vent control valve. Do not apply tape to surfaces that will contact mating surfaces.

NOTE

The filter tool may be gently hand-formed (to provide a convexed shape), in the area of the pressure-sensitive tape, to apply additional pressure on the seals when the tool is taped on the control valve or filter.

k. Attach valve (7), with seals and filter (on engines incorporating MD333 change), to helium regulator with bolts (6). Torque bolts to 24-26 in-lb.

l. Remove tape that secures filter tool to valve (7).

m. While applying a slight pressure on control valve (7) in direction of helium regulator, loosen bolts (6) approximately 1/4 turn, carefully remove filter tool, and retorque bolts to 24-26 in-lb.

n. Check impressions on Teflon tape on filter tool to make sure seals (2, 4) are correctly positioned. If tape does not have a circular impression of each of the 3 seals or if tape is cut or torn, remove valve, seals, and (on engines incorporating MD333 change) filter and reinstall as outlined in steps c, e, and g through n.

o. Cross-torque (section I) bolts (6) to 72-88 in-lb.

p. Install any line support clamps that were removed to gain access to helium control valve. Torque screws to 24-30 in-lb.

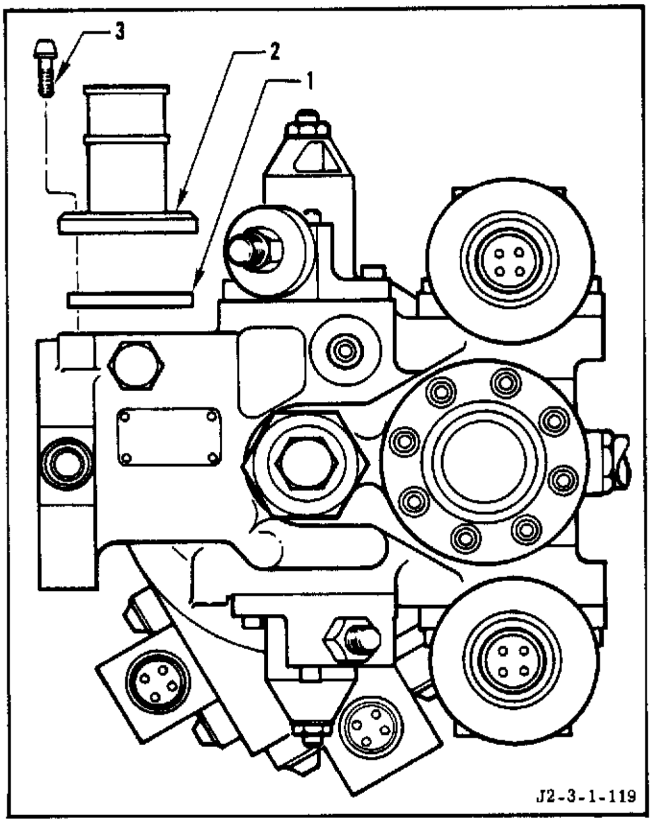
q. Connect electrical connector (paragraph 3-31) P17 (1).

r. Remove polyethylene (or equivalent) sheet from below helium tank emergency vent control valve.

3-145. HIGH-PRESSURE RELIEF VALVE.

3-146. REMOVING HIGH-PRESSURE RELIEF VALVE. (See figure 3-36.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.



Index No.	Description
1	Seal
2	Relief valve
3	Screw

Figure 3-36. High-Pressure Relief Valve

b. Remove screws, valve, and seal. If high-pressure relief valve is to be replaced on engines incorporating MD272 change, remove rain-maze cover and retain for installation on new valve. Protect open ports and sealing surfaces.

c. Install clean protective closures on all open ports. (Refer to paragraph 3-258.)

3-147. INSTALLING HIGH-PRESSURE RELIEF VALVE. (See figure 3-36.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure high-pressure relief valve, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

CAUTION

Excessive torque can distort the valve body and affect the relief pressure setting.

c. Remove protective covering, and install seal, relief valve, and screws. Torque screws to 4.5 to 5.5 in-lb above running torque. On engines incorporating MD272 change, install rain-maze cover.

d. Refer to section IV for test requirements.

3-147A. HYDROGEN TANK PRESSURIZATION LINE.

NOTE

This procedure is not applicable to SII center engines.

3-147B. REMOVING HYDROGEN TANK PRESSURIZATION LINE. (See figure 3-36A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. On engines incorporating hydrogen tapoff outlet line (HF2), cut line at first straight section from adapter in hydrogen tank pressurization line. (Refer to section VI for tube cutting requirements.) Protect open line ends. (See figure 3-36A, detail A.)

c. Remove bolts, washers, and nuts that secure hydrogen tank pressurizing line to thrust chamber mating flange; remove seal; retain bracket for reinstallation; and protect open ports and sealing surfaces.

d. Remove all nuts, washers, screws, and clamps from hydrogen tank pressurization line that are used to support lines and harnesses. Leave clamps attached to lines and harnesses to maintain clamping location.

e. Remove nuts, washers, screws, and clamps that secure oxidizer bleed line, oxidizer tank pressurization line, fuel bleed line, and hydrogen tank pressurization line to front and rear bar assemblies; then remove screws, washers, nuts, and 2 bar assemblies.

f. On installed engines, remove hydrogen tank pressurization line flange attaching hardware from customer connect interface panel using Stage Contractor procedures. Protect open ports and sealing surfaces.

g. Remove hydrogen tank pressurization line from engine.

h. If hydrogen tank pressurization line is to be replaced, remove plugs and gaskets from leak-test ports in flange and tapoffport (HF2), and remove plug and seal or adapter and seal, if applicable, from tapoff port (HF2) in hydrogen tank pressurization line. Protect open ports and sealing surfaces.

i. Remove protective material and install clean protective closures (paragraph 3-258).

3-147C. INSTALLING HYDROGEN TANK PRESSURIZATION LINE. (See figure 3-36A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure hydrogen tank pressurization line, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Remove protective material from hydrogen tank pressurization line flange (engine connection) and thrust chamber mating flange. Position

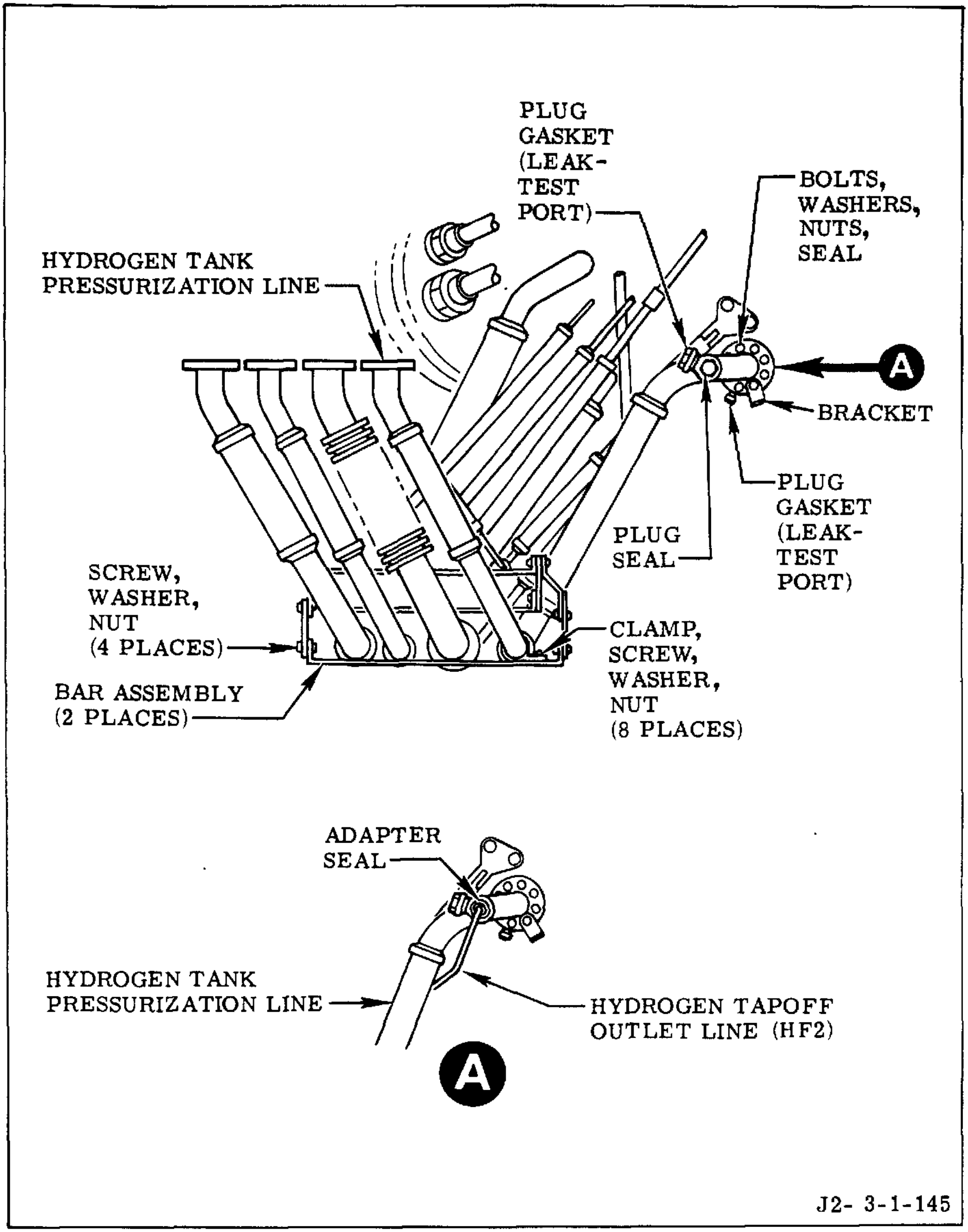


Figure 3-36A. Hydrogen Tank Pressurization Line

hydrogen tank pressurization line on engine and install seal, bracket, bolts, washers, and nuts. Torque bolts to 30-40 in-lb.

NOTE

Washers with chamfered inside diameters are installed under boltheads with the chamfer toward the bolthead.

d. On installed engine, remove protective material from hydrogen tank pressurization line flange and customer connect interface panel, and install seal and attaching hardware using Stage Contractor procedures.

e. Install 2 bar assemblies using screws, washers, and nuts. Do not torque nuts at this time.

f. Install clamps, screws, washers, and nuts to secure oxidizer bleed line, oxidizer tank pressurization line, fuel bleed line, and hydrogen tank pressurization line to front and rear bar assemblies. Torque screws to 24-30 in-lb.

g. Torque nuts to screws that secure the 2 bar assemblies until linkage locks and bar assemblies will not move; then back off nuts 1/2 turn and check for freedom of movement. Linkage must not bind.

h. Install all clamps, screws, washers, and nuts on hydrogen tank pressurization line that support lines and harnesses. Torque screws to 24-30 in-lb.

i. If hydrogen tank pressurization line was replaced, remove protective material and install plugs and gaskets in leak-test ports in flange (engine connection) and tapoff port (HF2) boss, if applicable. Install plugs fingertight.

NOTE

Plugs will be removed during leak test. After leak test, plugs will be reinstalled, torqued to 22-28 in-lb, and safetywired.

j. Remove protective material and install plug and seal or adapter and seal, if applicable, in tapoff port (HF2). Torque plug to 67-73 in-lb and safetywire plug, or torque adapter to 67 in-lb. If adapter did not move, proceed to next step. If adapter moved, remove and replace adapter and seal, and torque adapter to 67-73 in-lb.

k. On engines incorporating hydrogen tapoff outlet line (HF2), remove protective material from cut ends of line and weld line. (Refer to section VI for welding requirements.)

l. Refer to section IV for test requirements.

3-148. IGNITION-PHASE AND MAINSTAGE CONTROL VALVES.

3-149. REMOVING IGNITION-PHASE AND MAINSTAGE CONTROL VALVES. (See figure 3-37.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Move boot (12) and disconnect electrical connector (paragraph 3-30) P14 (10) and/or P15 (11).

c. Remove bolts (9) and washers (8) from manifold (6); then remove seal (7). Protect open ports and sealing surfaces.

d. Remove bolts (5) that hold valve in place; then remove valve (3 or 4). Protect open ports and sealing surfaces.

e. Install clean protective closures (paragraph 3-258).

3-150. INSTALLING IGNITION-PHASE AND MAINSTAGE CONTROL VALVES. (See figure 3-37.)

a. If control valve is being replaced, verify that solenoid valve preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain volt-ohm-milliammeter (model 603A, Triplett), or equivalent.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure valve, mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Using a volt-ohm-milliammeter, perform ignition-phase and/or mainstage control valve resistance-to-ground test as follows:

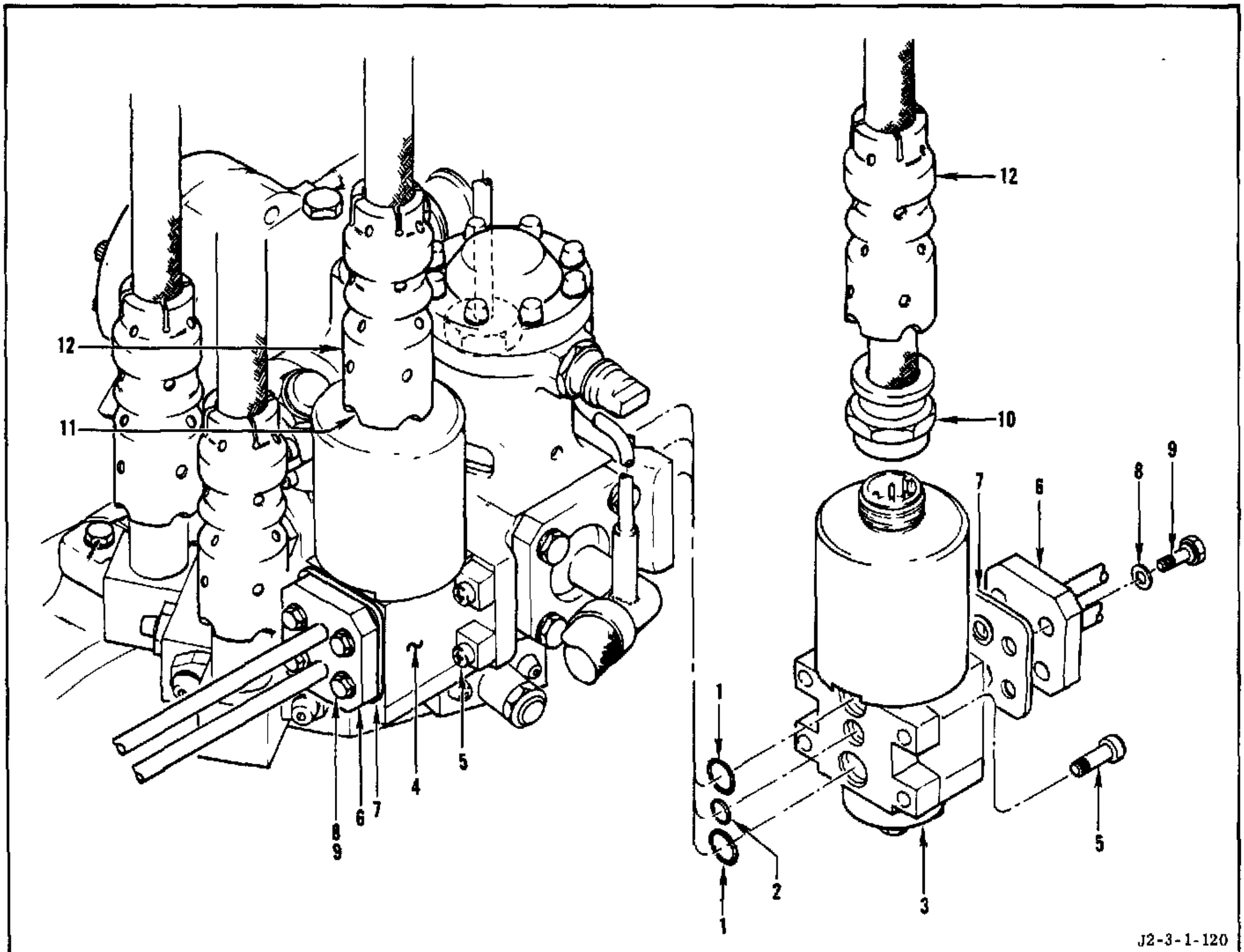
(1) Measure resistance between pins A and B. Resistance must be 14-23 ohms.

(2) Measure from A and B to ground, C to ground, and A and B to pin C. Resistance must be 50 megohms minimum.

e. Remove protective covering, install seals (1 and 2) and valve (3 and 4), then install bolts (5). Torque bolts to 23-30 in-lb above running torque.

f. Remove protective covering from seal (7) and inspect seal for evidence of white deposits. Remove loose white deposits by wiping seal with a clean lint-free cloth. Replace seal if deposits cannot be removed by wiping.

fA. Install seal (7), manifold (6), washers (8), and bolts (9). Torque bolts to 26-28 in-lb above running torque and safetywire bolts.



Index Number	Description	Index Number	Description
1	Seal	7	Seal
2	Seal	8	Washer
3	Ignition-phase control valve	9	Bolt
4	Mainstage control valve	10	Electrical connector P14
5	Bolt	11	Electrical connector P15
6	Manifold	12	Boot

Figure 3-37. Ignition-Phase and Mainstage Control Valves

g. Install electrical connector (paragraph 3-31) P14 (10) and/or P15 (11), as applicable.

h. Install boot (12) on electrical connector.

i. Refer to section IV for test requirements.

3-151. IGNITION DETECTOR PROBE.

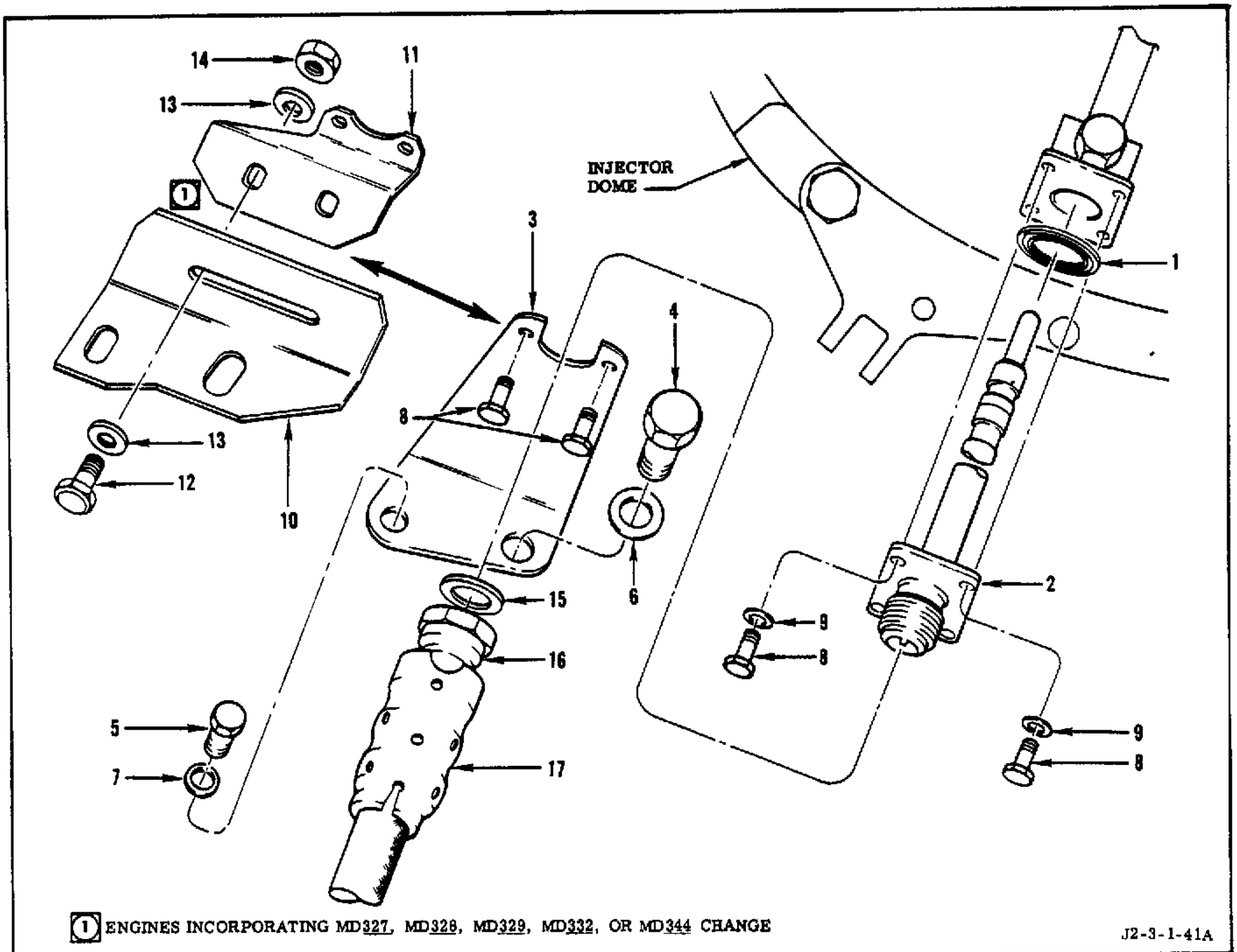
3-152. REMOVING IGNITION DETECTOR PROBE. (See figure 3-38.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove electrical connector (paragraph 3-30) P19 (16).

c. Remove armored harness support clamps from bracket on flange of hydrogen tank pressurization line.

d. Remove bolts (8) and washers (9).



Index Number	Description	Index Number	Description
1	Seal	10	Bracket
2	Ignition detector probe	11	Bracket
3	Bracket	12	Bolt
4	Bolt	13	Washer
5	Bolt	14	Nut
6	Washer	15	Seal
7	Washer	16	Electrical connector P19
8	Bolt	17	Thermal protecting boot
9	Washer		

Figure 3-38. Ignition Detector Probe

CAUTION

During removal of the ignition detector probe, extreme care must be taken to prevent damaging the fragile tip, bending the wire link at the end of the probe, or damaging the sealing surfaces.

e. Remove bolts (4, 5) and washers (6, 7), and then remove ignition detector probe (2) and seal (1).

f. Install clean protective closures (paragraph 3-258) on open port of ignition detector probe housing.

3-153. INSTALLING IGNITION DETECTOR PROBE. (See figure 3-38.)

a. Obtain reaming tool T-5047110.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. See figure 3-39 and perform the following visual inspection prior to installing probe: (Reject probe if it does not meet requirements of inspection.)

CAUTION

Extreme care must be used when handling the ignition detector probe to prevent damage to the wire link and ceramic tip.

(1) Make sure index dot on ceramic tip is alined within 30 degrees of electrochemically etched scribe mark on probe shank.

(2) Make sure scribe mark is oriented 90 degrees from plane of electrical connector key.

(3) Make sure plane formed by wire-link loop is alined within 30 degrees of electrical connector key.

(4) Make sure metal foil is securely spot-welded across retaining nut/probe shank joint, with no visible tears, cracks, loose spot welds, wrinkles, or folds in foil that indicate tampering or prevent proper installation.

(5) Make sure X-ray inspection stamp is present on metal foil.

(6) Make sure wire-link forms a continuous open loop and is not bent, crushed, broken, or otherwise damaged.

(7) Make sure wire-link is free from contamination.

d. Using resistance-measuring device that is accurate within one percent and capable of measuring resistance of 0.1, 100, 200, and greater than 100,000 ohms, perform resistance test on probe at the following locations: (Reject probe if it does not meet requirements of resistance test.)

CAUTION

The applied voltage must not exceed 5 vdc during performance of substeps 1, 2, and 3.

(1) Pin A to pin B: 100 ±2.5 ohms

(2) Pin B to pin C: 100 ±2.5 ohms

(3) Pin A to pin C: 200 ±5 ohms

(4) Pin B to pin D: greater than 100,000 ohms

(5) Pin B to probe electrical receptacle case: greater than 100,000 ohms

(6) Pin D to probe electrical receptable case: greater than 100,000 ohms

(7) Pin F to probe electrical receptacle case: less than 0.1 ohm

(8) Pin D to pin E: less than 0.1 ohm

e. Remove protective closure (paragraph 3-257) from ignition detector probe housing.

f. Make sure probe housing, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

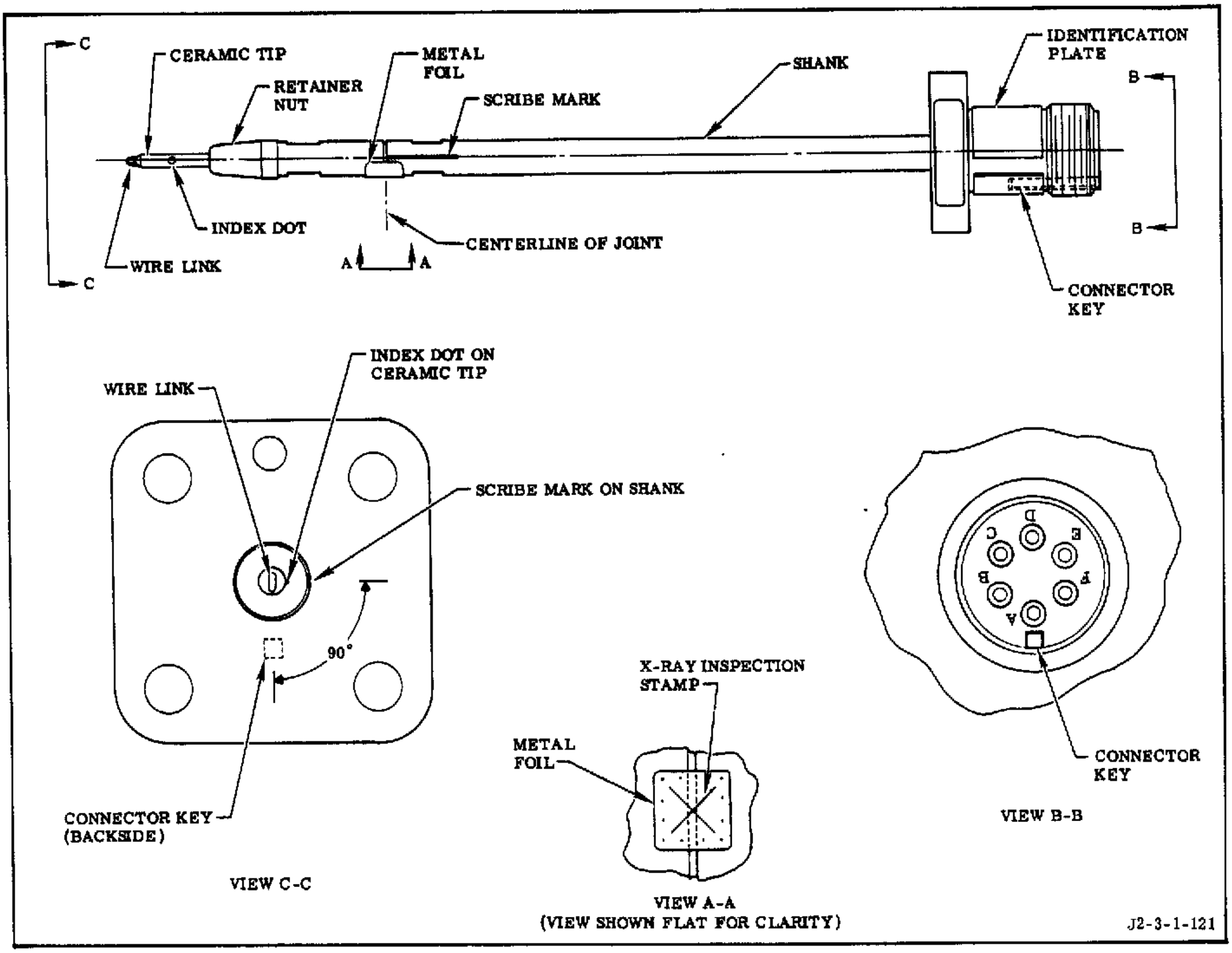


Figure 3-39. Inspecting Ignition Detector Probe

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

CAUTION

While blowing out the probe housing, care must be taken to prevent damage to the probe housing flange sealing surface.

g. Before installing probe, blow out ASI probe housing for 15 seconds or longer with low-pressure (less than 30 psig) gaseous nitrogen, air, or helium (paragraphs 1-83 through 1-84A) to remove any loose particles or residue that could cause probe to bind inside probe housing during installation and removal.

CAUTION

Extreme care must be taken to prevent bumping the fragile tip of the probe on the probe housing.

h. Carefully position probe with electrical connector key 180 degrees from oxidizer dome.

CAUTION

Care must be taken not to snag, scrape, bend, or otherwise damage edges of foil spot-welded across the retaining nut/probe shank joint.

i. Carefully insert new ignition detector probe through ASI into ASI combustion zone as follows:

CAUTION

If the probe is forced into the housing during installation, the probe may become jammed in the housing resulting in extensive damage to engine equipment.

(1) If any resistance or binding is encountered, do not force probe. Withdraw probe, and perform steps j and k.

(2) If probe can be inserted into housing without resistance or binding, until probe flange and housing flange meet without a gap, carefully withdraw probe and proceed to step l.

CAUTION

Housing must be reamed by hand only, to prevent damaging the probe housing.

- When inserting reamer, care must be taken to prevent damaging the probe housing flange sealing surface.

j. Carefully insert reaming tool T-5047110 into probe housing until resistance is encountered. Using a T-handle tap wrench, or equivalent, turn reamer 3 complete revolutions by hand; then withdraw reamer.

k. Repeat steps g through i. If resistance or binding recurs during probe installation, withdraw probe and repeat steps j and k until result described in step i, substep 2, is achieved; then proceed to step l.

CAUTION

The seal must not be removed from the storage container until immediately prior to installation.

NOTE

Seals may be installed with either side next to the probe flange.

l. Remove new seal from protective storage container and visually inspect Teflon-coated sealing surfaces of seal to make sure sealing surfaces are free of nicks, scratches, and imperfections that can impair sealing capability. Reject seal if it does not meet requirements of inspection.

m. Install new seal (1, figure 3-38), on ignition detector probe (2).

CAUTION

Extreme care must be taken to prevent bumping the fragile tip of the probe on the probe housing.

n. Position probe (2) with electrical connector key 180 degrees from oxidizer dome.

CAUTION

During installation, care must be taken not to bend or damage the fusible wire link at the end of the probe; damage sealing surfaces; or snag, scrape, bend, or otherwise damage edges of foil spot-welded across the retaining nut/probe shank joint.

- During installation, care must be taken to make sure the seal is completely centered inside the ASI flange recess cavity.

o. Carefully insert new ignition detector probe through ASI into ASI combustion zone.

p. On engines not incorporating MD227, MD228, MD229, MD332, or MD344 change, proceed to step q. On engines incorporating MD227, MD228, MD229, or MD332, or MD344 change, proceed to step r.

q. Install bracket (3) and secure bracket and ignition detector probe (2) as follows:

(1) Install bracket (3) on injector dome with bolts (4, 5) and washers (6, 7). Tighten bolts fingertight.

(2) Install probe (2) with bolts (8) and washers (9). Tighten bolts fingertight.

(3) Torque bolts (5, 8) to 41-45 in-lb.

(4) Torque bolts (4) to 195-225 in-lb. Proceed to step s.

r. Install brackets (10, 11) and secure brackets and ignition detector probe (2) as follows:

(1) Install brackets (10, 11) on injector dome with bolts (4, 5) and washers (6, 7). Tighten bolts fingertight.

(2) Install probe (2) with bolts (8) and washers (9). Tighten bolts fingertight.

(3) Probe (2) alinement with probe housing can be adjusted by loosening bolts (4, 5, 12) and utilizing slotted holes in brackets (10, 11) to adjust probe for optimum fit.

(4) Torque bolts (5, 8) to 41-45 in-lb.

(5) Torque bolt (4) to 195-225 in-lb.

(6) Torque nuts (14) to 50-60 in-lb.

s. If seal 408767-5 is installed, proceed to step v. If seal 404659 or 408767 is installed, proceed to step t.

t. Visually inspect ASI flange to probe flange joint to make sure seal is centered in ASI probe flange and is not cocked. If seal is cocked, remove probe, obtain new seal, and repeat steps l through t.

NOTE

If one of the 4 sides of the probe is inaccessible for a gap measurement, measurements taken on 3 sides are acceptable.

u. Using 0.001 to 0.020 inch feeler gages, measure gap between probe flange and ASI flange on each of the 4 sides of joint. If either of the following conditions exists, remove probe, obtain new seal, and repeat steps l through u.

(1) If measured gap exceeds 0.020 inch, seal is improperly seated or wrong seal has been installed.

(2) If no gap exists, wrong seal has been installed.

NOTE

With the seal properly centered and the bolts torqued, the gap should be between 0.005 to 0.015 inch and the variance between measured values should be less than 0.010 inch.

v. Repeat step d; results must be the same.

w. Using new seal (15), connect electrical connector (paragraph 3-31) P19 (16) to ignition detector probe. Safetywire connector.

x. Install thermal protecting boot (17).

y. Install clamp on armored harness and secure to bracket on flange of hydrogen tank pressurization line with screw, washer, and nut. Torque screw to 24-30 in-lb.

z. Refer to section IV for test requirements.

3-154. INSULATION (SILICONE-BASE AND POLYURETHANE).

3-155. REMOVING INSULATION (SILICONE-BASE AND POLYURETHANE).

3-156. This procedure is applicable to all components that are insulated with adhesive-mounted, silicone-base foam or polyurethane foam insulation. Adhesive-mounted component insulation can be replaced but not reinstalled.

a. The following materials and equipment are required:

(1) Polyethylene masking material

(2) Masking tape, 2-inch

(3) Sharpened plastic or wooden scraper

(4) Toluene (Federal Specification TT-T-548)

(5) Trichloroethylene (MIL-T-27602)

(6) Neoprene gloves

(7) Clean, lint-free cotton cloth

b. Using masking material and masking tape, protect engine components from falling debris.

c. Remove straps and buckles from insulation (where installed).

d. Remove insulation and adhesive by cutting and scraping with a sharpened wooden or plastic scraper.

WARNING

The following procedure specifies toluene, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

Care must be taken to avoid dripping toluene on any insulation that is not being removed since toluene destroys insulation and adhesive.

e. Wearing neoprene gloves, remove any remaining bits of insulation and adhesive by wetting them with a cloth dampened with toluene (Federal Specification TT-T-548).

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

f. Clean exposed surfaces by wiping with a clean, lint-free cotton cloth dampened with trichloroethylene (MIL-T-27602).

3-157. <u>INSTALLING INSULATION (SILICONE-BASE AND POLYURETHANE.</u>

3-158. These procedures are applicable to components that are to be insulated with precast silicone-base foam and precast polyurethane foam insulation segments. The polyurethane foam insulation is placed around a component and secured by adhesive applied to the mating edges of each segment. The installation of the silicone-base foam insulation requires that the surface of the component be carefully cleaned and that a catalyzed adhesive be used to secure the foam segments to the component surface. The time limitations for the catalyzed adhesive require that the entire procedure for preparing and applying adhesives, and applicable installation procedures, be completely read before the work is started. (See figure 3-40.) Install insulation as follows:

a. Oxidizer turbopump volute (paragraph 3-162).

b. Oxidizer inlet duct (paragraph 3-163).

c. Oxidizer high-pressure duct (paragraph 3-164).

d. ECA (paragraph 3-165).

e. MFV (paragraph 3-166).

f. ECA support rod (paragraph 3-167).

g. Fast-shutdown valve (paragraph 3-168).

h. OTBV (paragraph 3-169).

3-159. CLEANING AND PRIMING COMPONENTS PRIOR TO INSTALLING SILICONE-BASE INSULATION. The component surfaces must be cleaned and primed so that the adhesive used to install the silicone-base foam insulation will adhere securely to the component. The engine must be in a vertical position when performing this task. Component serial numbers are to be verified with those listed in the Engine Log Book before insulation is installed.

a. The following materials are required:

(1) Polyethylene masking material

(2) Acetate-fiber masking tape, 2-inch

(3) Cheesecloth

(4) Trichloroethylene (MIL-T-27602)

(5) Cleaner Turco 4142 (Turco Products)

(6) Filler brush 265-A (Osborne Mfg Co)

(7) Distilled water

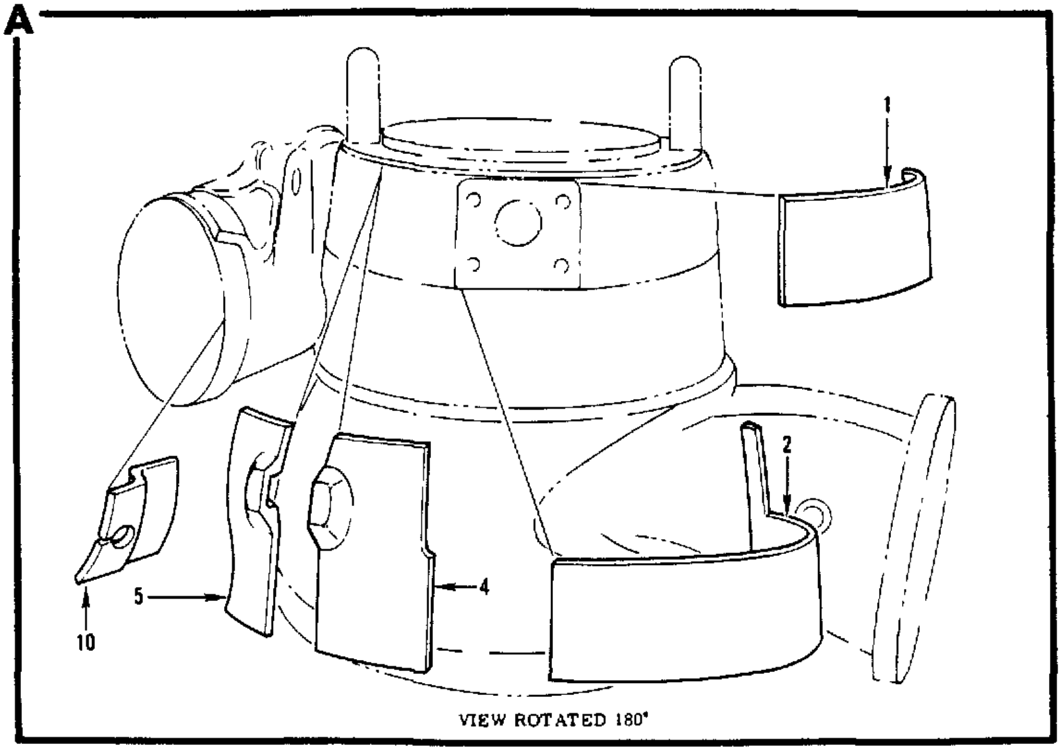
(8) Silicone primer RB0120-036 (Rocketdyne)

(9) Natural-bristle paintbrush, 2 inches wide. (Cut bristles to a one-inch length.)

(10) Acetone (Federal Specification O-A-51)

(11) Naphtha (Federal Specification TT-N-95)

(12) Wire brush 46-SS (Gordon Brush Mfg Co)



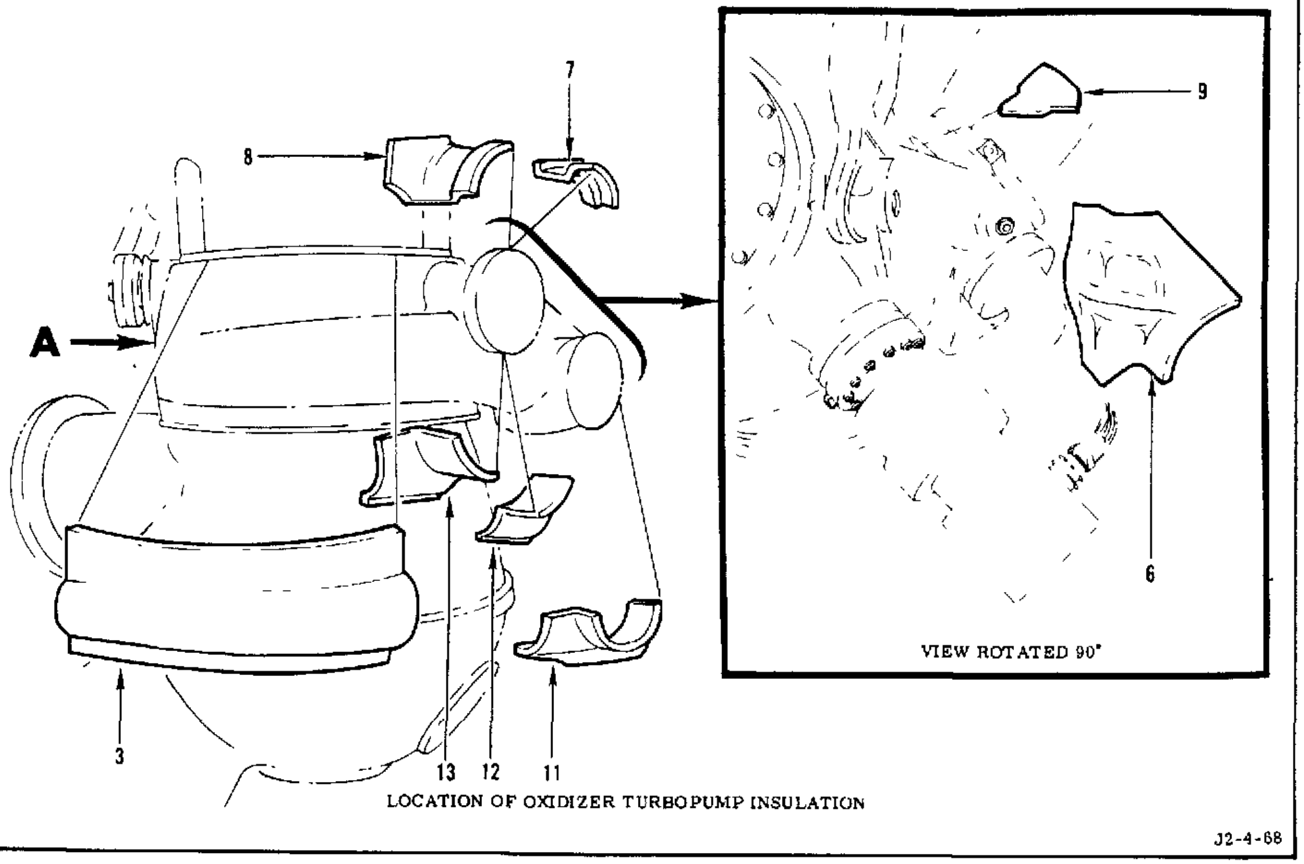
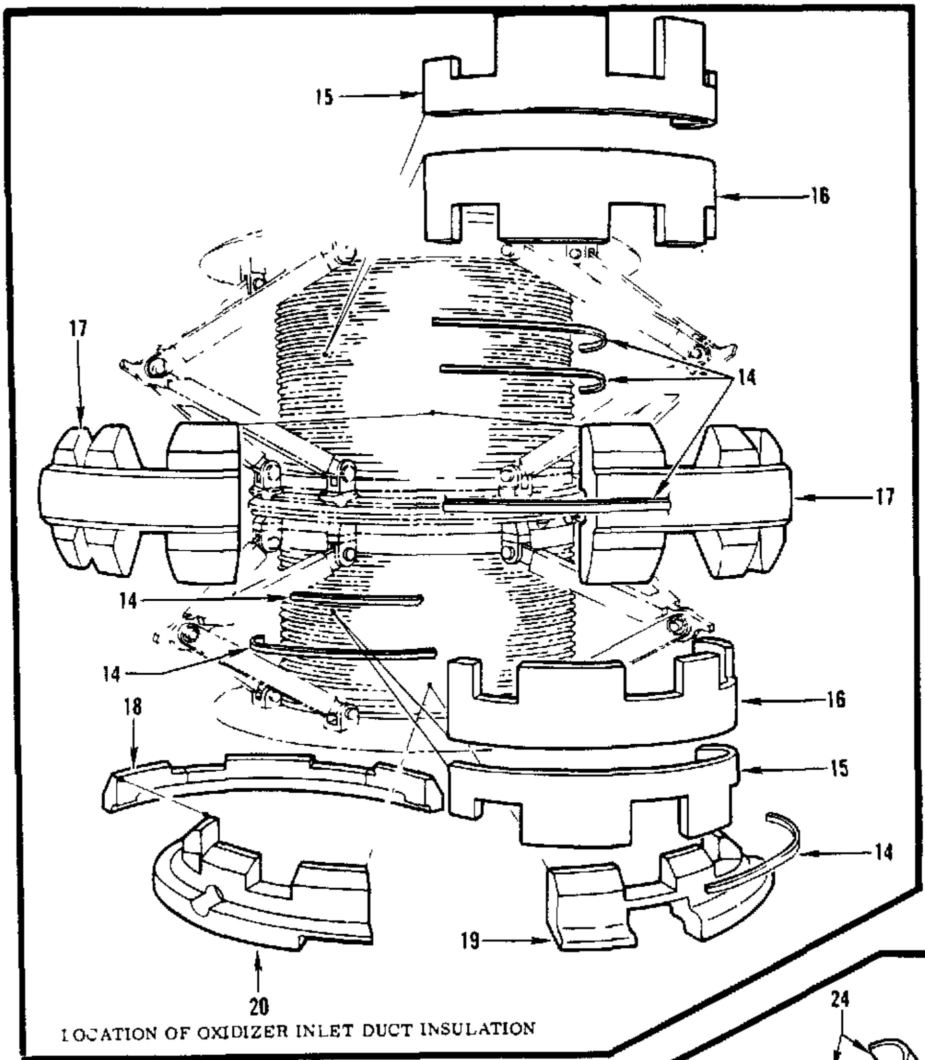


Figure 3-40. Component Insulation (Silicone-Base and Polyurethane) (Sheet 1 of 5)



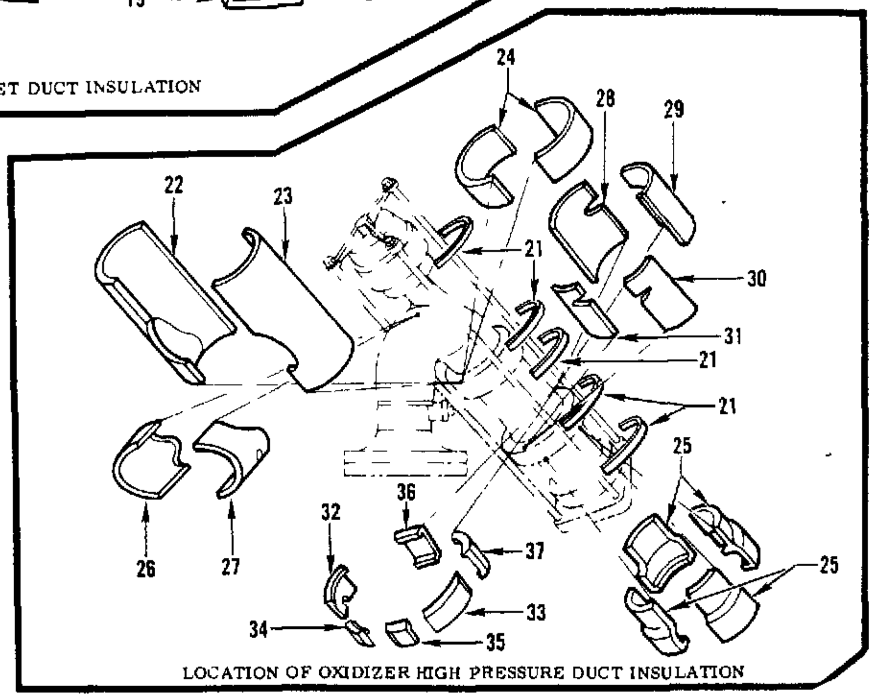


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Figure 3-40. Component Insulation (Silicone-Base and Polyurethane) (Sheet 2 of 5)

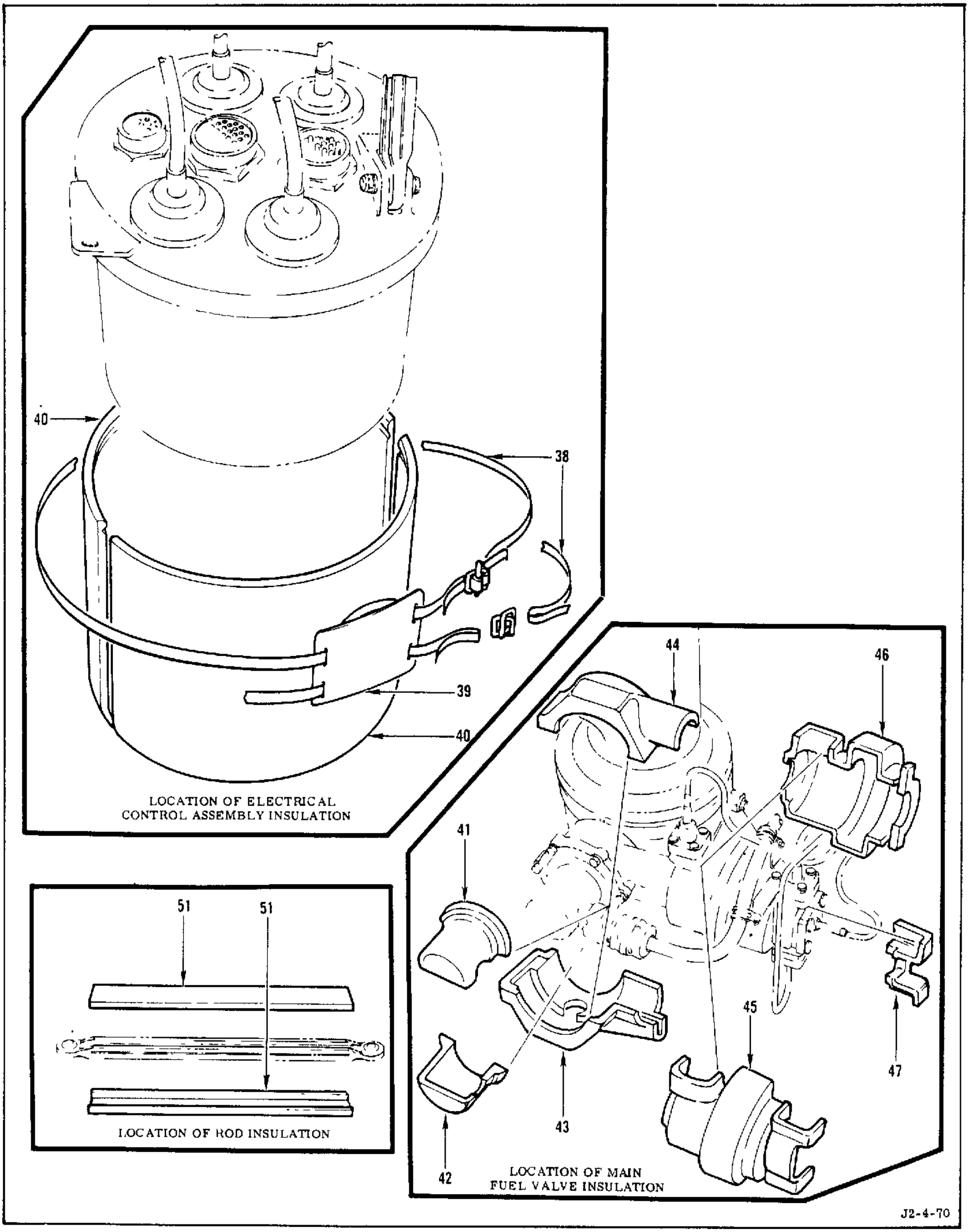
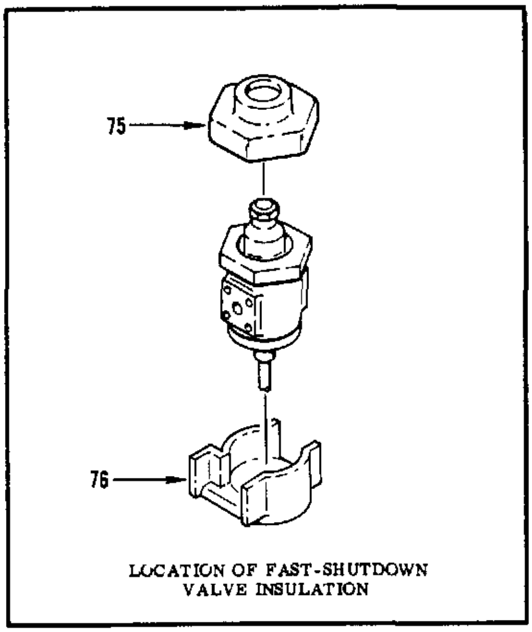
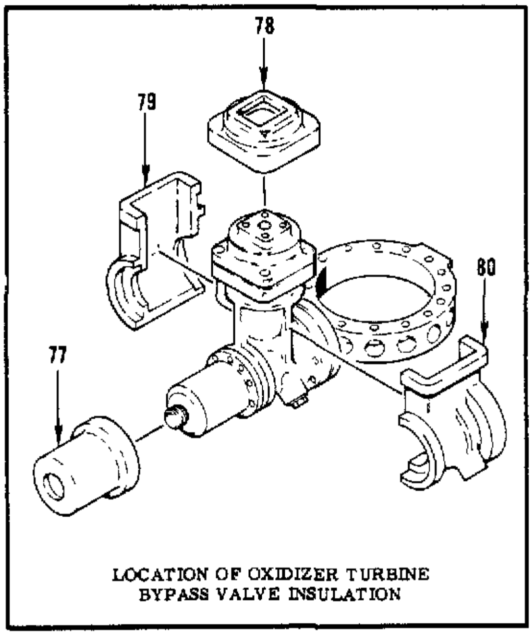


Figure 3-40. Component Insulation (Silicone-Base and Polyurethane) (Sheet 3 of 5)





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Index Number	Part Number	Description	Quantity Required on Change	
		Oxidizer Turbopump Pump Volute	MD251	MD252
1	146002-5	Insulator	1	1
2	146002-3	Insulator	1	1
3	146002-27	Insulator	1	1
4	146002-29	Insulator	1	1
5	146002-33	Insulator	1	1
6	146002-25	Insulator	1	1
7	146002-7	Insulator	1	1
8	146002-13	Insulator	1	1
9	146003-23	Insulator	1	1
10	146002-19	Insulator	1	1
11	146002-9	Insulator	1	1
12	146002-15	Insulator	1	1
13	146002-17	Insulator	1	1
		Oxidizer Inlet Duct	MD251	
14	209744-27	Strap	6	
15	146003-3	Insulator	4	
16	146003-5	Insulator	4	
17	146004	Insulator	3	
18	146005	Insulator	1	
19	146005-5	Insulator	1	
20	146005-3	Insulator	1	

Figure 3-40. Component Insulation (Silicone-Base and Polyurethane)(Sheet 4 of 5)

Index Number	Part Number	Description	Quantity Required on Change	
		Oxidizer High-Pressure Duct	MD251	MD252
21	209744-25	Strap	7	7
22	146016-1	Insulator	1	1
23	146016-2	Insulator	1	1
24	146011	Insulator	2	2
25	146007	Insulator	4	4
26	146019-1	Insulator	1	1
27	146019-2	Insulator	1	1
28	146013-1	Insulator	1	1
29	146013-2	Insulator	1	1
30	146014-1	Insulator	1	1
31	146014-2	Insulator	1	1
32	146009-3	Insulator	1	1
33	146009-5	Insulator	1	1
34	146010-3	Insulator	1	1
35	146010-5	Insulator	1	1
36	146012-3	Insulator	1	1
37	146012-5	Insulator	1	1
		Electrical Control Assembly	MD224	MD249
38	209748-5	Strap	3	3
39	503115	Caution Plate	1	1
40	503109	Insulator	2	2
		Main Fuel Valve	MD224	MD225
41	503116-1	Insulator	1	1
42	503116-2	Insulator	1	1
43	503113	Insulator	1	
44	503114	Insulator	1	
45	503111	Insulator	1	
46	503112	Insulator	1	
47	503110	Insulator	1	
		Electrical Control Assembly Support Rod	MD224	MD225
51	209741	Insulator	2	2
		Fast-Shutdown Valve	MD292	
75	146052	Insulator	1	
76	146053	Insulator	1	
		Oxidizer Turbine Bypass Valve	MD292	
77	146054-3	Insulator	1	
78	146054-9	Insulator	1	
79	146054-5	Insulator	1	
80	146054-7	Insulator	1	

Figure 3-40. Component Insulation (Silicone-Base and Polyurethane) (Sheet 5 of 5)

b. Using masking material and masking tape, protect electrical wiring, nonmetal surfaces, and components not being cleaned, from cleaning chemicals. (Leave masking material in place until insulation installation procedures are completed.)

WARNING

The following procedure specifies naphtha and acetone, which are flammable and must not be used near heat, sparks, or open flame. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury.

c. If hydraulic oil is present on component surface, clean with cheesecloth moistened with naphtha (Federal Specification TT-N-95). To accelerate evaporation of naphtha, wipe surfaces using a clean cloth moistened with acetone (Federal Specification O-A-51).

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

d. Using a small wire brush and cheesecloth dampened with trichloroethylene (MIL-T-27602), clean surfaces to be insulated a minimum of 2 times. (Pour trichloroethylene onto cloth to avoid contaminating clean solvent.)

e. For engines not installed, clean stainless-steel surfaces as follows:

CAUTION

The alkaline cleaner used in the following steps can cause galvanic action in electrical connectors if deposits of the solution are not removed after the cleaning task is completed. For this reason, the alkaline cleaner must not be used when the engine is installed in a stage where thorough flushing cannot be done.

(1) Prepare an alkaline cleaning solution by mixing cleaner Turco 4142 (Turco Products) with hot water in ratio of 1/4 pound of cleaner to 2-1/2 quarts of water. (Cold water may be used if cleaner is dissolved thoroughly.) Varying quantities of solution may be prepared provided the ratio of cleaner to water is maintained.

(2) Clean surfaces to be insulated with alkaline cleaning solution using filler brush 265-A (Osborne Mfg Co) and cheesecloth.

CAUTION

In the following step failure to remove all traces of alkaline solution will prevent adhesion of adhesive.

(3) Remove alkaline solution completely by rinsing surfaces with distilled water.

f. Omit water-break test on oxidizer turbopump and MFV, since surfaces are too rough to permit a successful test. Perform a water-break test by spraying a small amount of distilled water on cleaned surface. An unbroken water film indicates that surface is clean. If water forms into small droplets, repeat steps c through f until an unbroken water film is attained.

g. After a successful water-break test, allow surfaces to drip-dry thoroughly. (Drying may be accelerated by wiping with a clean, dry cloth.)

WARNING

The following specifies silicone primer RB0120-036, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

h. Apply a liberal coat of silicone primer RB0120-036 (Rocketdyne) with a paintbrush to cleaned surfaces of component being insulated. In areas where surfaces are inaccessible to brush, apply primer with a clean, lint-free cloth. (Donot allow primer to contact vent port check valves.) All surfaces must be primed thoroughly to make sure insulation adhesive bonds to component surface.

i. Allow primer to dry thoroughly, approximately one hour. Primer turns white when dry.

j. When primer is dry, remove all white coating from primed surfaces by wiping with a clean, dry, lint-free cloth immediately before installation of insulation.

NOTE

Surfaces must be inspected for cleanness if installation delay exceeds 24 hours. Surfaces must be recleaned if delay exceeds 3 days.

k. If insulation is not to be installed immediately, protect cleaned and primed surfaces by covering with clean masking material. Moisture must not contact cleaned and primed surfaces.

3-160. PREPARING AND APPLYING CARTRIDGE ADHESIVES. The cartridge adhesives are supplied with a slow-curing catalyst. (See figure 3-41.) Before preparing an adhesive for use, a test mix must be prepared and tested. If the test mix is acceptable, a mix with the same lot number and void date must be used in the application of the insulation. Adhesive must not be prepared until directed in the applicable component insulation installation procedure. Adhesive, insulation, and component must be maintained in an environment of 86° ±14° F during application of insulation and the first 8 hours of the adhesive curing period. The procedure must be completely read before preparing the cartridge adhesives.

a. The following materials and equipment are required:

(1) Adhesive cartridge as specified in applicable installation procedure

(2) Open container, one-quart

(3) Nozzle 8630-9 (Semco Sales and Service)

(4) Nozzle 620 (Semco Sales and Service)

(5) Sealant gun 250 (Semco Sales and Service)

(6) Hose 220-20 (Semco Sales and Service)

(7) Retainer 602, 606, or 608 (Semco Sales and Service) for 2-1/2, 6-, or 8-ounce cartridges, respectively

(8) Natural-bristle paintbrush, 2 inches wide. (Cut bristles to a one-inch length.)

WARNING

The following specifies an adhesive, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

b. Test-mix adhesive cartridge as follows: (See figure 3-41.)

(1) Check lot number and void date. Make sure shelf life has not expired.

(2) Precondition separable dasher rods (only), at a temperature of 100° ±10° F for 8 hours; then maintain temperature at 86° ±14° F until used. An alternate method of preconditioning dasher rods is to maintain rods at a temperature of 86° ±14° F for a minimum of 72 hours just prior to use.

Adhesive Specification	Adhesive Cartridge[a]	Catalyst	Cartridge Size (Ounces)	Pot Life (Minutes)
RB0120-029 (slow-curing)				
Type I	SF-667-RTV560/9950	RTV-9950	8	60
Type II	SF-650-RTV560/9950	RTV-9950	6	60

(a) RTV-560 adhesive base used in cartridges

Figure 3-41. Adhesive Cartridges

(3) Pull dasher rod out approximately half way.

(4) Insert ramrod into hole in top of dasher rod. Push ramrod until it hits bottom. (This injects catalyst into adhesive base material.) Slow-curing adhesive is usable for approximately 60 minutes after mixing.

(5) Remove and discard ramrod.

(6) Mix catalyst into base material by stroking 25-30 complete strokes for slow-curing adhesive, turning dasher clockwise twice on each inward and outward movement.

(7) Pull dasher rod out to fully extended position, and unscrew dasher rod (approximately 3 turns) while gripping cartridge in area of dasher.

(8) Remove and discard dasher rod and bottom cap.

(9) Place mixed contents of cartridge into an open container.

(10) Inspect test sample 1-1/2 to 2-1/2 hours after mixed contents are placed in an open container by attempting to groove surface of adhesive in several places. If surface cannot be grooved or if surface is grooved and adhesive does not refill grooves, adhesive is acceptable; proceed to step c. If adhesive continues to refill grooves, adhesive is unacceptable.

c. Prepare adhesive cartridge for installing insulation as outlined in step b, substeps 1 through 8. Make sure cartridge is from same lot number as used for acceptable test mix.

CAUTION

Improper threading of the nozzle into the plastic cartridge can destroy the mating threads.

d. Carefully screw appropriate nozzle into cartridge, and place cartridge into sealant gun.

e. Connect pressure hose to sealant gun and to a 60-80 psig gaseous nitrogen or air supply.

f. Apply adhesive to mating surfaces of insulation segments with sealant gun as evenly as possible to a thickness of 0.015 to 0.025 inch. Install insulation segments immediately as directed in applicable procedure. When installing insulation around or near vent port check valves, make sure adhesive does not contact vent port check valves.

3-161. PREPARING AND APPLYING HAND-MIXED ADHESIVES. The adhesive base material and catalyst are supplied in bulk form to be hand-mixed immediately before use. A fast curing or slow-curing adhesive can be prepared by using a different catalyst. (See figure 3-42.) The catalyst requirement is specified in the applicable component insulation installation procedure. Before preparing an adhesive for use, a test mix must be prepared and tested. If test mix is acceptable, a mix with the same lot number and void date must be used in the application of the insulation. The adhesive, insulation, and component must be maintained in an environment of 86° ±14° F during application of insulation and the first 8 hours of the adhesive curing period. The procedure must be completely read before preparing the adhesive.

WARNING

The following specifies catalysts, which by themselves or when mixed with an adhesive base, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the materials. In case of contact, flush eyes with water for at least 15 minutes; wash skin with soap and water; and get medical attention.

a. The following materials and equipment are required:

(1) Adhesive RTV-560 (General Electric).

(2) Catalyst. One of the following catalysts will be specified in the applicable component insulation installation procedure:

(a) Catalyst (slow-curing) RTV-9950 (General Electric).

(b) Thermolite 12 (M & T Chemicals, Inc).

(c) Nuocure 28 (Tenneco Chemicals) (fast-curing).

(3) Neoprene gloves.

(4) Stainless-steel spatula, 6-inch blade.

(5) Natural-bristle paintbrush, 2 inches wide. (Cut bristles to a one-inch length.)

b. Test-mix a slow-curing adhesive (figure 3-42) as follows:

(1) Check lot number and void date. Make sure shelf life has not expired.

(2) Precondition catalyst RTV-9950 (General Electric) or Thermolite 12 (M & T Chemicals, Inc) at a temperature of 100° ±10° F for 8 hours; then maintain temperature at 86° ±14° F until used.

(3) Place a 20-gram lot of adhesive RTV-560 (General Electric) base in a glass, metal, or nonabsorbing container. Wear neoprene gloves when working with adhesive or catalyst.

(4) Place a 2-gram lot of adhesive RTV-9950 paste into adhesive base material. If using a liquid catalyst, use a medicine dropper and place one drop of Thermolite 12 into adhesive base.

(5) Using a 6-inch stainless-steel spatula, or equivalent, carefully stir components together. Thorough mixing should be done in less than 6 minutes.

(6) Inspect test sample 1-1/2 to 2-1/2 hours after substep 5 by attempting to groove surface of adhesive in several places. If surface cannot be grooved or if surface is grooved and adhesive does not refill grooves, adhesive is acceptable; proceed to step c. If adhesive continues to refill grooves, adhesive is unacceptable. If adhesive is unacceptable, repeat substeps 3 through 6 increasing amount of catalyst in increments of 1/2 gram paste catalyst or one drop liquid catalyst until mixture is acceptable. Record mixture ratio.

c. Test-mix fast-curing adhesive as follows:

(1) Check lot number and void date. Make sure shelf life has not expired.

(2) Place a 20-gram lot of adhesive RTV-560 (General Electric) base in a glass, metal, or nonabsorbing container. Wear neoprene gloves when working with adhesive or catalyst.

(3) Using a medicine dropper, place 3 drops of catalyst Nueocure 28 (Tenneco Chemicals) into adhesive base.

(4) Using a 6-inch stainless-steel spatula, or equivalent, carefully stir components together. Record time when reaction occurs (mixture can no longer be stirred). Reaction must occur within 7-10 minutes for an acceptable mixture ratio. Increase or decrease the amount of catalyst, and repeat substeps 2, 3, and 4 until reaction occurs within specified time. Change amount of liquid catalyst in one-drop increments. Increasing the amount of catalyst increases reaction time.

(5) Record mixture ratio determined in substep 4.

Adhesive Specification	Adhesive Base	Catalyst	Pot Life (Minutes)
RB0120-029 (slow-curing)			
Type III	RTV-560	RTV-9950	60
Type IV	RTV-560	Thermolite 12 (liquid)	60
RB0120-033 (fast-curing)			
Type IV	RTV-560	Nuocure 28	7-10

Figure 3-42. Hand-Mixed Adhesives

NOTE

Varying quantities of adhesive, as required by the installation, may be prepared if the mixture ratio is maintained.

d. Prepare 1/2 pound (approximately 225 grams) of hand-mixed adhesive for installing insulation. Refer to step b when mixing a slow-curing adhesive and step c when mixing a fast-curing adhesive. Make sure materials are from same lot number as used in test mix. Thorough mixing of slow-curing adhesive must be accomplished within 6 minutes, and fast-curing adhesive within 3 minutes. Use mixture ratio recorded in step c for fast-curing adhesive.

e. Apply adhesive mixture to mating surfaces of insulation with spatula. Use stiff, short-bristled brush to distribute adhesive uniformly to a thickness of 0.015 to 0.025 inch. Install insulation segments immediately, as directed in applicable procedure. When installing insulation around or near vent port check valves, make sure adhesive does not contact vent port check valves.

3-162. INSTALLING INSULATION ON OXIDIZER TURBOPUMP VOLUTE. The insulation consists of precast silicone-base insulation segments applied directly to the oxidizer turbopump volute on engines incorporating MD251 or MD252 change. (See figure 3-40.) The procedure must be completely read before the work is started.

a. The following materials and equipment are required:

(1) Insulator 146002-3

(2) Insulator 146002-5

(3) Insulator 146002-7

(4) Insulator 146002-9

(5) Insulator 146002-13

(6) Insulator 146002-15

(7) Insulator 146002-17

(8) Insulator 146002-19

(9) Insulator 146002-23

(10) Insulator 146002-25

(11) Insulator 146002-27

(12) Insulator 146002-29

(13) Insulator 146002-33

(14) Cleaning materials. (Refer to paragraph 3-159).

(15) Adhesive RB0120-033, Type IV (Rocketdyne) (figure 3-42)

(16) Toluene (Federal Specification TT-T-548)

(17) Silicone-base foam and catalyst RB0130-068 (Rocketdyne)

(18) External coating RB0120-030 (Rocketdyne)

(19) Neoprene gloves

(20) Clean, lint-free cotton cloth

(21) Sandpaper, 80-grit

(22) Artist brush, 1/8-inch diameter, hog bristle

b. Disconnect clamp assemblies that secure oxidizer bleed line and electrical harness, as follows, to allow sufficient movement while installing insulation: (Retain all parts for re-installation.)

(1) Remove screw, washer, and nut, and separate clamp from bracket 303287.

(2) Remove screw, washer, and nut, and separate clamp from bracket 502833-23.

(3) Remove screw, washer, and nut, and separate clamp from bracket 502827.

(4) Remove screw and nut, and separate clamps RE127-2005-0009 and RE127-2005-0015 two places.

c. Clean and prime surface of oxidizer turbopump volute. (Refer to paragraph 3-159.)

CAUTION

The precast insulation is very fragile and must be handled with care to prevent damage.

d. Dry-fit insulation segments to oxidizer turbopump volute in the following sequence: (Do not attempt to dry-fit insulation segment 146002-7. If segments do not contact surface of volute when being fitted together, trim segments, as needed, using a sharp knife or sandpaper until good surface contact is made easily.) (See figure 3-40.)

(1) 146002-29

(2) 146002-33

(3) 146002-19

(4) 146002-9

(5) 146002-23

(6) 146002-25

(7) 146002-15

(8) 146002-17

(9) 146002-13

(10) 146002-3

(11) 146002-5

(12) 146002-27

e. If necessary, split insulator 146002-5 to allow radii of insulator and volute mounting pad to come into contact.

NOTE

Misalinement of insulators 146002-13, 146002-17, and 146002-27 due to allowable manufacturing tolerances may cause gaps. These gaps will be filled during accomplishment of step m after adhesive has cured.

f. Prepare adhesive. (Refer to paragraph 3-161.)

WARNING

The following specifies an adhesive, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

g. Quickly apply catalyzed adhesive to inside surface of insulator segments, one at a time, and install segments in the following sequence: (See figure 3-40.)

(1) 146002-29

(2) 146002-33

(3) 146002-19

(4) 146002-9

(5) 146002-23

(6) 146002-25

(7) 146002-15

(8) 146002-17

(9) 146002-7

(10) 146002-13

(11) 146002-3

(12) 146002-5

(13) 146002-27

h. Apply hand-pressure to initiate adhesion of insulator segments to oxidizer turbopump volute surface. Continue hand-pressure for 3-5 minutes.

i. Apply additional adhesive, as necessary, to joints between edges of insulation segments and volute flanges and into any areas where insulation is not adhering to volute surface.

j. Provide an environment of 86° ±14° F for first 8 hours (minimum) of 24-hour curing period.

k. After 24 hours, remove protective film from surface of each segment.

WARNING

The following procedure specifies toluene, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

The cloth must not be soaked with toluene since excess toluene destroys insulation and adhesive.

l. Using a clean cloth partially dampened with toluene (Federal Specification TT-T-548), clean any adhesive that may have smeared on surface of insulation.

WARNING

The following specifies silicone-base foam and catalyst, RB0130-068, which may irritate skin. Protective clothing must be worn when handling material. In case of contact, wash skin with soap and water.

m. Gaps and cavities of 3/16 inch or more between insulating segments must be filled, and gaps of less than 3/16 inch may be filled with silicone-base foam and catalyst RB0130-068 (Rocketdyne) as follows:

(1) Slightly undercut edges of insulation around area to be filled, to provide a better bond for new insulation material.

(2) Prepare a clean surface on which to mix silicone-base and catalyst. Surface may be glass sheet metal, polyethylene, Mylar, or other suitable disposable material. If plastic sheeting is used, it must be secured in place, to prevent movement during hand-mixing operation.

(3) Wear neoprene gloves.

(4) Select a 25-, 50-, or 100-gram kit of preweighed, uncatalyzed silicone-base foam and catalyst. Amount selected is determined by size of gap or cavity to be filled.

(5) Pour foam material (component A) onto mixing surface and pat into a flat shape. (Foam material is catalyzed by mixing 3.3 parts, by weight, of catalyst with 100 parts of foam material.)

(6) Pour approximately 1/2 of catalyst (component B) evenly onto material. Quickly mix by kneading manually. Pat flat, add remainder of catalyst, and knead well.

CAUTION

This catalyzed mixture must be used in less than 10 minutes after adding catalyst, since curing begins immediately. A longer delay can result in failure of insulation to adhere to component.

(7) Immediately press catalyzed material firmly into gaps or cavities to be filled.

(8) Allow material to cure for 4 hours.

(9) After curing, carefully trim off excess material using a sharp knife, and blend surface of surrounding area with 80-grit sandpaper.

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

(10) After trimming or sanding, remove loose particles with low-pressure (less than 30 psig) gaseous nitrogen (paragraph 1-84) or air (paragraph 1-84A), or by brushing.

WARNING

The following specifies external coating RB0120-030, which may irritate skin. Protective clothing must be worn when handling coating. In case of contact, wash skin with soap and water.

n. Apply a thick coat of external coating RB0120-030 (Rocketdyne) to all uncoated areas (only) of insulation as follows:

(1) Prepare silicone-base coating RB0120-030 (Rocketdyne) by adding catalyst (component B) to coating (component A) and stirring. Mix in ratio of one gram of catalyst (approximately 53 drops) to 160 grams of coating base.

CAUTION

This catalyzed material must be used in less than 15 minutes after adding catalyst, since curing begins immediately. A longer delay can result in failure of coating to adhere to insulation.

(2) Quickly apply catalyzed coating, using a natural-bristle paintbrush. Final brush strokes should be in one direction only. Do not use thickened material.

NOTE

The catalyzed coating must be applied quickly, and with extreme care, since it is apt to run and can drip onto other surfaces.

(3) Allow coating to cure 72 hours before handling. (This cure period does not affect launch schedules.)

o. Reinstall clamp assemblies and attaching hardware disconnected, in step b.

p. Remove any plastic sheeting and masking tape used to protect engine components.

3-163. INSTALLING INSULATION ON OXIDIZER INLET DUCT. (See figure 3-40.) The insulation consists of precast polyurethane foam segments placed around the oxidizer inlet duct on engines incorporating MD251 change. The procedure must be completely read before the work is started.

WARNING

The following specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. The following materials and equipment are required:

(1) Four insulators 146003-3

(2) Four insulators 146003-5

(3) Three insulators 146004

(4) One insulator 146005

(5) One insulator 146005-3

(6) One insulator 146005-5

(7) Six nylon webbing straps 209744-27 (Rocketdyne)

(8) Six buckles AVB-4 (FMC Corp)

(9) White sealant RTV-102 (General Electric)

(10) Sandpaper, 16-grit, with sanding block (or equivalent)

b. Dry-fit the 4 insulators 146003-5 around inlet duct bellows adjacent to center flange. Using hacksaw or coarse sandpaper, trim insulators as necessary to obtain 0.125 ±0.010 inch clearance between bellows and insulators all the way around. To retain roundness and prevent binding, trim equal amounts from one end only of each mating insulator, but trim only one of any 2 facing surfaces. Leave insulator in place.

c. Dry-fit the 4 insulators 146003-3 around inlet duct bellows and against insulators 146003-5. Trim insulator as necessary to obtain 0.125 ±0.010 inch clearance and to prevent any buckling. (Trim one end only of each mating insulator as specified in step b.) Remove all insulators.

CAUTION

Care must be taken when applying adhesive. If an excessive amount of adhesive is used, it can be forced from the joints when the strap is tightened. This would create a bead on either or both sides of the insulation that could cause binding during gimbaling.

d. Carefully apply an even coat of white sealant RVT-102 (General Electric) to mating surfaces of each of the 4 insulators 146003-3 and the 4 insulators 146003-5, and install insulators. Secure each pair with nylon straps 209744-27 (Rocketdyne) and buckles AVB-4 (FMC Corp). Handtighten straps.

e. Firmly press pairs of insulators together and hold in place until adhesive starts to set.

f. Dry-fit the 3 insulators 146004 around center flange of inlet duct. Trim insulators as necessary to obtain 0.090 ±0.010 inch clearance all the way around between insulators 146004 and insulators 146003-5. (Trim equal amounts from one end only as specified in step b.)

g. Carefully apply an even coat of white sealant RTV-102 (General Electric) to each end of the 3 insulators 146004. Install insulators around center flange and secure with strap 209744-27 (Rocketdyne) and buckle AVB-4 (FMC Corp). Handtighten strap.

h. Dry-fit the 3 insulators 146005, 146005-3, and 146005-5 around exit-end flange of the inlet duct. Trim insulators as necessary to obtain 0.090 ±0.010 inch clearance all the way around between these insulators and insulators 146003-3. (Trim equal amounts from one end only as specified in step b.)

i. Carefully apply an even coat of white sealant RTV-102 to each end of the 3 insulators 146005, 146005-3, and 146005-5, and install insulators. Secure with strap 209744-27 and buckle AVB-4. Handtighten strap.

j. Allow adhesive to dry for 24 hours; then remove and discard the 4 straps (and buckles) that secure insulators 146003-3 and 146003-5 around inlet duct bellows. (Do not remove the 2 straps that secure insulators around center and exit-end flanges, since they are part of installation.)

3-164. INSTALLING INSULATION ON OXIDIZER HIGH-PRESSURE DUCT. The insulation consists of precast polyurethane foam segments placed around the oxidizer pump discharge duct on engines incorporating MD251 and MD252 changes. The procedure must be completely read before the work is started. (See figure 3-40.)

WARNING

The following specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

a. The following materials and equipment are required:

(1) Four insulators 146007

(2) One insulator 146009-3

(3) One insulator 146009-5

(4) One insulator 146010-3

(5) One insulator 146010-5

(6) Two insulators 146011

(7) One insulator 146012-3

(8) One insulator 146012-5

(9) One insulator 146013-1

(10) One insulator 146013-2

(11) One insulator 146014-1

(12) One insulator 146014-2

(13) One insulator 146016-1

(14) One insulator 146016-2

(15) One insulator 146019-1

(16) One insulator 146019-2

(17) Six nylon webbing straps 209744-25 (Rocketdyne)

(18) Six buckles AVB-4 (FMC Corp)

(19) White sealant RTV-102 (General Electric)

(20) Sandpaper, 16-grit, with sanding block (or equivalent)

b. Dry-fit insulators 146016-1 and 146016-2 around oxidizer pump discharge duct. Trim insulators only if necessary using hacksaw blade or coarse sandpaper.

c. Apply an even coat of white sealant RTV-102 (General Electric) to mating surfaces, and install insulators.

d. Secure insulators with nylon strap 209744-25 (Rocketdyne) and buckle AVB-4 (FMC Corp). Handtighten strap.

e. Dry-fit insulators 146019-1 and 146019-2. Trim only if necessary. Apply an even coat of white sealant RTV-102 to mating surfaces, to ends abutting insulators 146016-1 and -2, and to mating surfaces on insulators 146016-1 and -2. Install insulators on duct. Secure with straps, as specified in step d, so that insulators 146019-1 and -2 are held together and against insulators 146016-1 and -2.

f. Dry-fit insulators 146013-1, 146013-2, 146014-1, and 146014-2. Trim only if necessary. Apply an even coat of white sealant RTV-102 and install on duct. Secure with strap as specified in step d.

g. Dry-fit insulators 146009-3, 146009-5, 146010-3, 146010-5, 146012-3, and 146012-5. Trim only if necessary. If gap exists due to manufacturing tolerances, obtain polyurethane foam material of similar thickness and contour from field site supplies. Trim material as necessary to fill gap. Apply an even coat of white sealant RTV-102 and install on duct. Secure with strap as specified in step d.

h. Dry-fit 2 insulators 146011. Trim only if necessary. If gap exists due to manufacturing tolerances, insulators may be shifted to equally divide gaps smaller than 3/8 inch. These smaller gaps will be filled during accomplishment of step j. Gaps greater than 3/8 inch must be filled using spare insulator 146011 as filler material. Cut a segment (using a sharp knife, or equivalent) from spare insulator to fill gap. Apply an even coat of white sealant RTV-102 and install on duct. Secure with strap as specified in step d.

i. Dry-fit 4 insulators 146007. Trim only if necessary. Apply an even coat of white sealant RTV-102 and install on duct. Secure with strap as specified in step d.

j. Fill all cracks and gaps wider than 1/16 inch with white sealant RTV-102.

k. Allow adhesive to dry for 24 hours; then remove and discard straps securing insulators 146019-1 and -2 against insulators 146016-1 and -2. (Do not remove other straps since they are part of installation.)

3-165. INSTALLING INSULATION ON ELECTRICAL CONTROL ASSEMBLY. The insulation consists of precast silicone-base foam segments applied directly to the ECA on engines incorporating MD224 or MD249 change. (See figure 3-40.) The procedure must be completely read before the work is started.

a. The following materials and equipment are required:

(1) Two insulation segments 503109

(2) Identification plate 503115 (Rocketdyne)

(3) Two nylon webbing straps 209748-5 (Rocketdyne)

(4) Two buckles AVB-4 (FMC Corp)

(5) Portable vacuum pump No. 54906 (Van Waters and Rogers, Inc)

(6) Vacuum hose No. 56433 (Van Waters and Rogers, Inc), (1/4-inch ID (3/16-inch wall thickness)

(7) Vacuum adapter No. 146023 (Rocketdyne)

(8) Plastic bag (Polyfab Co), 24 inches long, 28 inches wide, and 6 mils thick

(9) Two rubber bands No. 107 (Dykema Rubber Band Co)

(10) Hair-felt weatherstrip No. 97487 (Sears Roebuck and Co), 4 one-foot sections

(11) Presstite tape 587.3 (Interchemical Corp), 1/8 inch thick by 1/2 inch wide, or zinc chromate sealer (W. P. Fuller Co) one roll, 3/8-inch wide, 3/16-inch thick

(12) Cleaning and priming materials (Refer to paragraph 3-159.)

(13) Adhesive RB0120-029, Type I (Rocketdyne) (figure 3-41) or adhesive RB0120-029, Type IV (Rocketdyne) (figure 3-42)

(14) Toluene (Federal Specification TT-T-548)

(15) Clean, lint-free cotton cloth

b. Clean and prime surface of ECA enclosure. (Refer to paragraph 3-159.) Do not clean or prime ECA mounting plate.

CAUTION

The precast insulation is very fragile and must be handled with care to prevent damage.

c. Dry-fit insulation segments around ECA enclosure. Place first segment on outboard side of ECA and rotate segment 180 degrees to inboard side. Add second segment. Remove and trim as necessary.

d. Apply Presstite tape 587.3 (Interchemical Corp) around entire circumference of flange at forward end of ECA to hold and seal plastic bag when bag is installed later.

WARNING

The following specifies adhesive RB0120-029, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

e. Prepare hand-mixed adhesive RB0120-029 (Rocketdyne) in accordance with paragraph 3-161, or cartridge adhesive RB0120-029 (Rocketdyne) in accordance with paragraph 3-160.

f. Quickly apply catalyzed adhesive to inside surfaces of insulator segments and install segments in same manner as they were dry-fitted. Apply hand-pressure to initiate adhesion of insulation segments to surface.

g. Place 4 felt strips longitudinally on surface of insulation segments 90 degrees apart but away from insulation seam. Secure insulation segments to ECA with 2 rubberbands placed circumferentially over felt strips.

h. Install plastic bag over ECA, and seal bag against Presstite tape 587.3 (Interchemical Corp) previously applied.

i. Install vacuum tube fitting through plastic bag by cutting a small hole in bag near one of the felt strips. Insert fitting so that tube rests one felt strip, and apply Presstite tape 587.3, to seal plastic bag to vacuum tube fitting.

j. Attach hose from vacuum pump to vacuum tube fitting.

k. Turn on vacuum pump, and manually push insulation segments into place as air is being evacuated from plastic bag.

l. Maintain a vacuum of 20 ±5 inches of mercury for a minimum curing period of 24-hours.

m. Monitor vacuum pump for indication of overheating. If overheating occurs, cool pump with fan or gaseous nitrogen (MIL-P-27401), as needed.

n. Provide an environment of 86° ±14° F for first 8 hours (minimum) of 24-hour curing period.

o. After 24 hours, turn vacuum pump off; disconnect and store vacuum hose.

p. Remove plastic bag from ECA, and remove vacuum tube fitting from bag. Discard bag.

q. Remove Presstite tape 587.3 from circumference of flange at forward end of ECA.

r. Remove rubberbands and felt strips.

s. Remove protective film from surface of each insulation segment.

WARNING

The following procedure specifies toluene, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

The cloth must not be soaked with toluene since excess toluene destroys insulation and adhesive.

t. Using a clean cloth partially dampened with toluene (Federal Specification TT-T-548), clean any adhesive that may have smeared on surface of insulation.

u. Install identification plate 503115 (Rocketdyne) (CAUTION-GAS-PRESSURE-HANDLE-WITH-CARE) using 2 straps 209748-5 (Rocketdyne) and buckles AVB-4 (FMC Corp). Locate plate on outboard side of ECA (top edge forward) so that forward edge of forward strap is 5.00 ±0.25 inches from ECA flange. Hand-tighten straps.

v. Remove any plastic sheeting and masking tape used to protect engine parts.

3-166. INSTALLING INSULATION ON MAIN FUEL VALVE. The insulation consists of precast silicone-base foam segments applied directly to the MFV. Only two insulation segments (503116-1 and -2) are required on engines incorporating MD225 change. (See figure 3-40.) The procedure must be completely read before the work is started.

a. The following materials and equipment are required:

(1) Insulator 503110 (molded together with 503112)

(2) Insulator 503111

(3) Insulator 503112

(4) Insulator 503113

(5) Insulator 503114

(6) Insulator 503116-1

(7) Insulator 503116-2

(8) Nylon webbing strap 209744 (Rocketdyne)

(9) Buckle AVB-4 (FMC Corp)

(10) Cleaning and priming materials (Refer to paragraph 3-159.)

(11) Adhesive RB0120-033, Type IV (Rocketdyne) (figure 3-42)

(12) Toluene (Federal Specification TT-T-548)

(13) Clean, lint-free cotton cloth

b. Disconnect clamp, screw, and nut from MFV to allow sufficient movement of electrical cable while installing insulation. Retain all parts for reinstallation.

c. Clean and prime surfaces of MFV. (Refer to paragraph 3-159.)

d. On engines incorporating MD225 change, dry-fit insulation segments to MFV as outlined in substeps 1 and 2. On engines incorporating MD224 change, dry-fit insulation segments to MFV as outlined in substeps 1 through 8. If segments do not contact surface of MFV when being fitted together, it is necessary to trim segments with a sharp knife or sandpaper until good surface contact is made easily.

CAUTION

The precast insulation is very fragile and must be handled with care to prevent damage.

(1) Dry-fit forward segment 503116-1.

(2) Dry-fit aft segment 503116-2.

(3) Separate insulation segments 503110 and 503112 (were molded together).

(4) Dry-fit inboard segment 503112.

(5) Dry-fit outboard segment 503111.

(6) Dry-fit segment 503110 carefully, cutting notch to fit around flange leak-test plug.

(7) Dry-fit aft half of actuator housing segment 503113.

(8) Dry-fit forward half of actuator housing segment 503114.

e. Prepare adhesive. (Refer to paragraph 3-161.)

WARNING

The following specifies an adhesive, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

f. Quickly apply catalyzed adhesive to inside surface of insulator segments, one at a time, and install them in the same order as they were dry-fitted. Apply hand-pressure to initiate adhesion of insulator segments to MFV surface. Continue hand-pressure approximately 3 minutes.

g. On engines incorporating MD224 change, install nylon strap 209744 (Rocketdyne) and buckle AVB-4 (FMC Corp) around insulation segments 503113 and 503114. Handtighten only.

h. Provide an environment of 86° ±14° F for first 8 hours (minimum) of 24-hour curing period.

i. After completion of 24 hours (minimum), relieve clamping action of buckle AVB-4 by bending with pliers. Remove nylon strap and buckle and discard.

j. Remove protective film from surface of each insulation segment.

WARNING

The following procedure specifies toluene, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

The cloth must not be soaked with toluene since excess toluene destroys insulation and adhesive.

k. Using a clean cloth partially dampened with toluene (Federal Specification TT-T-548), remove any adhesive that may have smeared on surface of insulation.

l. Reinstall clamp assembly and attaching hardware disconnected in step b.

m. Remove any plastic sheeting and masking tape used to protect engine parts.

3-167. INSTALLING INSULATION ON ELECTRICAL CONTROL ASSEMBLY SUPPORT ROD. The insulation consists of two precast silicone-base foam segments applied directly to the surface of the ECA support rod on engines incorporating MD224 or MD225 change. (See figure 3-40.) The procedure must be completely read before the work is started.

a. The following materials and equipment are required:

(1) Two insulation segments 209741

(2) Cleaning and priming materials (Refer to paragraph 3-159.)

(3) Adhesive RB0120-029, Type I or Type II (Rocketdyne) (figure 3-41) or adhesive RB0120-029, Type IV (Rocketdyne) (figure 3-42)

(4) Toluene (Federal Specification TT-T-548)

(5) Clean, lint-free cotton cloth

(6) Portable vacuum pump No. 54906 (Van Waters and Rogers, Inc)

(7) Vacuum hose No. 56433 (Van Waters and Rogers, Inc) 1/4-inch ID (3/16-inch wall thickness)

(8) Vacuum adapter No. 146023 (Rocketdyne)

(9) Plastic bag (Polyfab Co), 24 inches long, 6 inches wide, and 6 mils thick

(10) Hair-felt weatherstrip No. 9 7487 (Sears Roebuck and Co)

(11) Presstite tape 587.3 (Interchemical Corp), 1/8 inch thick by 1/2 inch wide, or zinc chromate sealer (W.P. Fuller Co) one roll, 3/8 inch wide, 3/16 inch thick

b. Remove ECA support rod from engine; clean and prime surface. (Refer to paragraph 3-159.)

c. Dry-fit insulation segments 209741 around support rod. Trim, as necessary, and remove.

d. Prepare adhesive. (Refer to paragraph 3-161.)

WARNING

The following specifies an adhesive, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

e. Quickly apply adhesive to inside surfaces of insulation segments and install segments in same manner as they were dry-fitted. Apply hand-pressure to initiate adhesion of insulation segments to surface.

f. Place felt strips longitudinally on surface of insulation segments, but away from insulation seam. Secure insulation segments to ECA support rods with rubberbands placed circumferentially over felt strips.

g. Place support rods in plastic bag, and seal.

h. Install vacuum tube fitting through plastic bag by cutting a small hole in bag near one of the felt strips. Insert fitting so that tube rests on felt strip, and apply Presstite tape 587.3 (Interchemical Corp) to seal plastic bag to vacuum tube fitting.

i. Attach hose from vacuum pump to vacuum tube fitting.

j. Turn on vacuum pump, and manually push insulation segments into place as air is being evacuated from plastic bag.

WARNING

Compressed gas must not be used for cooling unless effective chip guarding is used and personal protection equipment is worn.

k. Maintain a vacuum of 14-16 inches of mercury for a 24-hour curing period. Monitor vacuum pump for indication of overheating. If overheating occurs, cool pump with fan or flow of low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401).

l. Provide an environment of 86° ±14° F for first 8 hours (minimum) of 24-hour curing period.

m. After 24 hours, turn off vacuum pump and disconnect.

WARNING

The following procedure specifies toluene, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

The cloth must not be soaked with toluene since excess toluene destroys insulation and adhesive.

n. Using a clean cloth partially dampened with toluene (Federal Specification TT-T-548), remove any adhesive that may have smeared on surface of insulation.

o. Remove any plastic sheeting and masking tape used to protect engine parts. Reinstall ECA support rod.

p. Install support rod with hardware removed in step b. Torque bolts until a 0.002-inch gap exists between nut and support surface. If interference exists between support rod and helium regulator supply line, the insulation may be compressed to obtain clearance.

3-168. INSTALLING INSULATION ON FAST-SHUTDOWN VALVE. The insulation consists of precast silicone-base foam segments applied directly to the fast-shutdown valve on engines incorporating MD292 change. (See figure 3-40.) The procedure must be completely read before the work is started.

a. The following materials and equipment are required:

(1) Insulator 146052

(2) Insulator 146053

(3) Self-adjusting straps MS17821-2-9

(4) Cleaning and priming materials (Refer to paragraph 3-159.)

(5) Adhesive RB0120-033, Type IV (Rocketdyne) (figure 3-42)

(6) Toluene (Federal Specification TT-T-548)

WARNING

The following procedure specifies trichloroethylene, which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

b. Clean with a small wire brush and cheesecloth dampened with trichloroethylene (MIL-T-27602) and prime surfaces of fast-shutdown valve. (Refer to paragraph 3-159.)

CAUTION

The precast insulation is very fragile and must be handled with care to prevent damage.

c. Dry-fit insulation segments around fast-shutdown valve. Insulator 146053 may be cut into halves for ease of installation. Trim insulator 146052 to clear lockwire cutout. It may be necessary to cut a hole in insulator 146052 for bracket.

d. Prepare adhesive. (Refer to paragraph 3-161 for hand mixed adhesive.)

WARNING

The following specifies an adhesive, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water, and get medical attention.

e. Apply adhesive to inside surfaces of insulators, and install insulators in same manner as they were dry-fitted. Apply hand-pressure to initiate adhesion of insulation segments to surface.

f. Secure insulation segments to fast-shutdown valve with self-adjusting straps.

g. Allow insulation to remain undisturbed during 24-hour (minimum) curing period. Temperature must be stabilized at 86° ±14° F for the first 8 hours.

h. Remove self-adjusting straps.

i. Remove protective film from surface of each insulation segment.

WARNING

The following procedure specifies toluene, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

The cloth must not be soaked with toluene since excess toluene destroys insulation and adhesive.

j. Using a clean cloth partially dampened with toluene (Federal Specification TT-T-548), clean any adhesive that may have smeared on surface of insulation.

k. Remove any plastic sheeting and masking tape used to protect engine parts.

3-169. INSTALLING INSULATION ON OXIDIZER TURBINE BYPASS VALVE. The insulation consists of precast silicone-base foam segments applied directly to the OTBV on engines incorporating MD292 change. The procedure must be completely read before work is started.

a. The following materials and equipment are required:

(1) Insulator 146054-3

(2) Insulator 146054-5

(3) Insulator 146054-7

(4) Insulator 146054-9

(5) Portable vacuum pump No. 54906 (Van Waters and Rogers, Inc)

(6) Vacuum hose No. 56433 (Van Waters and Rogers, Inc), 1/4-inch ID (3/16-inch wall thickness)

(7) Vacuum adapter No. 146023 (Rocketdyne)

(8) Presstite tape 587.3 (Interchemical Corp), 1/8 inch thick by 1/2 inch wide.

(9) Hair-felt weatherstrip No. 97487 (Sears Roebuck and Co)

(10) Polyethylene bag, 6 mils thick, 24 inches wide by 24 inches long

(11) Self-adjusting straps MS17821-2-9

(12) Toluene (Federal Specification TT-T-548)

(13) Adhesive RB0120-029, Type I or Type II (Rocketdyne) (figure 3-41) or adhesive RB0120-029, Type IV (Rocketdyne) (figure 3-42)

(14) Wire brush No. 46-SS (Gordon Brush Mfg)

WARNING

The following procedure specifies trichloroethylene which is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

b. Clean with a small wire brush and cheesecloth dampened with trichloroethylene (MIL-T-27062), and prime surfaces of OTBV. (Refer to paragraph 3-159.)

c. Disconnect electrical connector (paragraph 3-30) P117, and install protective closures (paragraph 3-258).

CAUTION

The precast insulation is very fragile and must be handled with care to prevent damage.

d. Dry-fit insulation segments around OTBV.

CAUTION

Tape or sealer must not be allowed to contact primed surface or to interfere with insulation when insulation is installed.

- Adhesive must not contact vent port check valve.

e. Apply Presstite tape 587.3 (Interchemical Corp), around entire circumference of mounting flange of OTBV.

WARNING

The following specifies an adhesive, which when mixed with catalyst, must not be allowed to contact the skin or eyes. Eye protection and protective clothing must be worn when handling the mixed substance. In case of contact, flush eyes for at least 15 minutes; wash skin with soap and water; and get medical attention.

f. Prepare adhesive RB0120-029, Type I or Type II (Rocketdyne) or adhesive RB0120-029, Type IV (Rocketdyne).

g. Apply adhesive to inside surfaces of insulator segments, and install segments in same manner as they were dry-fitted. Do not apply adhesive on surface that mates with side of vent port check valve. Apply hand-pressure to initiate adhesion of insulation segments to surface.

h. Place felt strips longitudinally on surface of insulation segments, but away from insulation seam. Secure insulation segments to OTBV with self-adjusting straps placed circumferentially over felt strips.

i. Install plastic bag over OTBV, and seal bag against tape previously applied.

j. Install vacuum tube fitting through plastic bag by cutting a small hole in bag near one of the felt strips. Insert fitting so that tube rests on felt strip, and apply Presstite tape 587.3 (Interchemical Corp) to seal plastic bag to vacuum tube fitting.

k. Attach hose from vacuum pump to vacuum tube fitting.

l. Turn on vacuum pump, and manually push insulation segments into place as air is being evacuated from plastic bag.

WARNING

Compressed gas must not be used for cooling unless effective chip guarding is used and personal protection equipment is worn.

m. Maintain a vacuum of 10-20 inches of mercury for 24-hours minimum curing period. Temperature must be stabilized at 86° ±14° F for first 8 hours. Monitor vacuum pump for indication of overheating. If overheating occurs, cool pump with fan or flow of low-pressure (less than 30 psig) gaseous nitrogen (MIL-P-27401), as needed.

n. After a minimum of 24 hours, turn off and disconnect vacuum pump.

o. Remove plastic bag from OTBV, and remove vacuum tube fitting from bag.

p. Remove Presstite tape 587.3 from OTBV.

q. Remove straps and felt strips.

r. Remove protective film from surface of each insulation segment.

WARNING

The following procedure specifies toluene, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

CAUTION

The cloth must not be soaked with toluene since excess toluene destroys insulation and adhesive.

s. Using a clean cloth partially dampened with toluene (Federal Specification TT-T-548), clean any adhesive that may have smeared on surface of insulation.

t. Connect electrical connector (paragraph 3-31) P117.

u. Remove any plastic sheeting and masking tape used to protect engine parts.

3-170. INTEGRAL HYDROGEN-HELIUM START TANK.

3-171. REMOVING INTEGRAL HYDROGEN-HELIUM START TANK (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-43.)

a. Obtain start tank installer 9016783-11 (used when engine is in Engine Handler G4064).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Prior to removing start tank, make sure tank has been purged in accordance with R-3825-1B since last time fuel was introduced into system.

d. Remove STDV (paragraph 3-266).

e. If engine is in engine handler, complete steps f through k. If engine is in unstacked stage proceed to step l.

NOTE

The integral hydrogen-helium start tank weighs approximately 89 pounds. If the engine is in the unstacked stage, suitable equipment must be used to support and move the start tank.

f. Install start tank installer 9016783-11 on forward end of Engine Handler G4064.

g. Adjust legs of start tank installer until tracks are level with engine handler.

h. Place start tank dolly on tracks of installer with each caster wheel on a black dot located on tracks of installer.

i. Adjust dolly to lowest position by turning knurled adjustment nuts above each of the 3 caster wheels.

j. Roll start tank dolly into position under start tank.

k. Raise dolly by turning adjustment nuts until rubber padding is snug against start tank and dolly will support start tank during disconnecting.

l. Disconnect electrical connector (paragraph 3-30) P123.

1A. If start tank is to be replaced, remove start tank gas temperature transducer (TFT1). (Refer to paragraph 3-134.)

m. Remove bolts, washers, and nuts that secure vent line bracket to support.

n. Remove screw, washer, and nut that secure control line clamp to bracket.

o. Cut lockwire and remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal.

p. Install clean protective closures (paragraph 3-258) on start tank and vent-and-relief valve.

q. Temporarily reposition and secure start tank vent-and-relief valve to provide lateral access for removal of integral hydrogen-helium start tank.

r. Cut lockwire and remove bolts and washers that secure start tank support-and-fill valve to tank. Remove seal. Protect open ports and sealing surfaces of tank and support-and-fill valve.

s. Remove electrical harness support clamps, as required, to gain access to helium cover attaching bolts.

t. Cut lockwire and remove bolts and washers that secure helium cover to start tank. Remove bracket. Protect open ports and sealing surfaces of tank and helium cover.

u. Remove bolt, washers, and pin that secure strut and link to mounting bracket located at STDV.

v. If engine is in engine handler, complete step w and omit step x. If engine is in unstacked stage, omit step w and proceed to step x.

CAUTION

The start tank must be moved directly away from the helium cover to prevent damage to the tube extending from the helium cover.

w. Carefully lower dolly to lowest position, remove helium cover seal, and roll start tank (89 pounds) clear of engine. Use care to prevent damaging sealing surfaces and tube extending from helium cover into start tank. Tube extends 3 inches into start tank so it will be necessary to clear tube when lowering tank.)

x. Slowly move start tank directly away from helium cover using care not to damage sealing surfaces and tube extending from helium cover into start tank. Tube extends into start tank 3 inches.

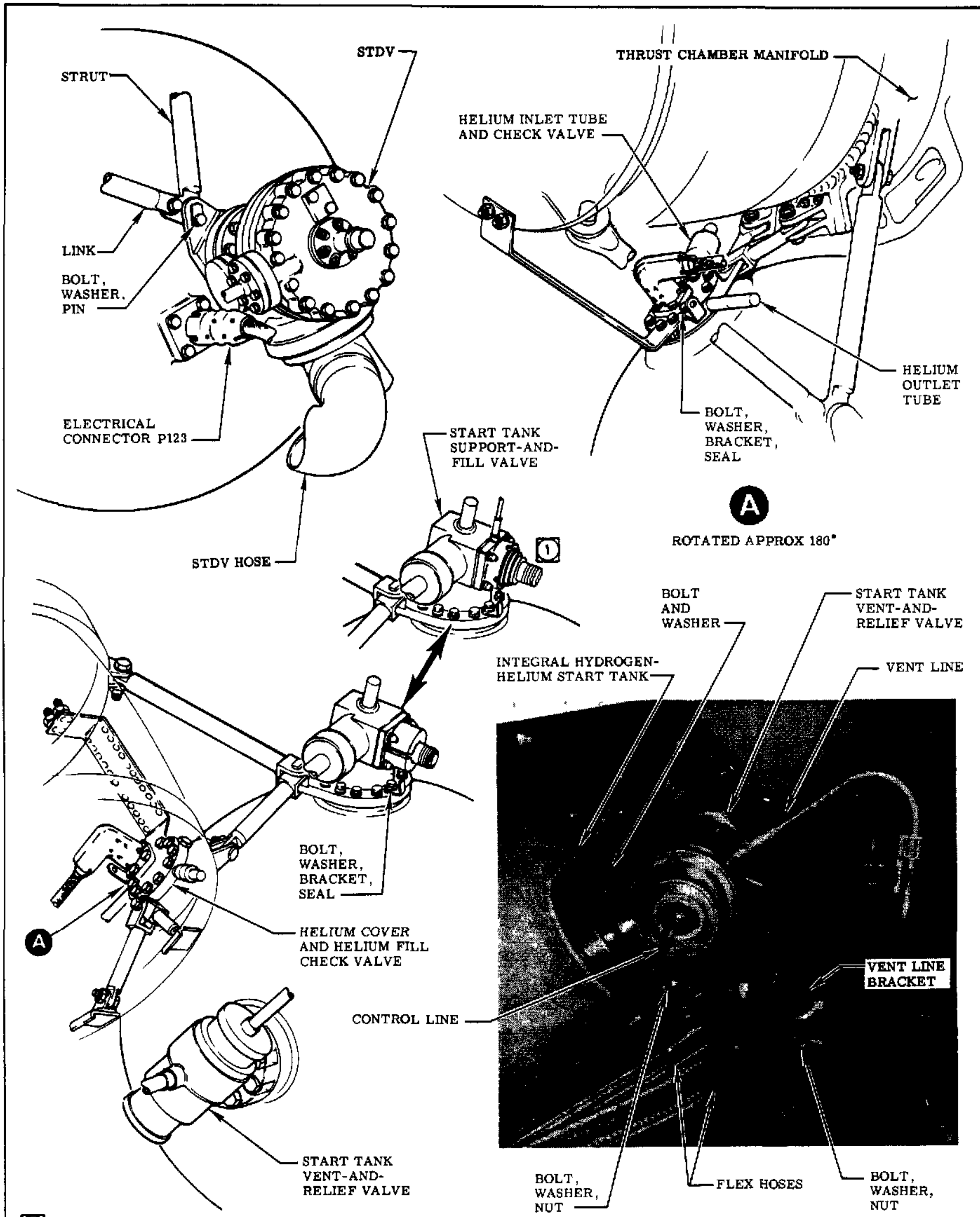


Figure 3-43. Integral Hydrogen-Helium Start Tank

y. Remove protective material from start tank ports and install clean protective closures (paragraph 3-258) on all open ports.

z. Remove protective material from support-and-fill valve and helium cover, and install clean protective closures (paragraph 3-258).

3-172. REMOVING INTEGRAL HYDROGEN-HELIUM START TANK (STACKED SII STAGE). (See figure 3-43.)

a. Obtain the following: (Items 5 through 9 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Start tank handler 9026139 from Engine Components Installer G4071, shelf 3. (Handler is required for removing tank from engine position 5.)

(2) Sling 9022985. (Sling is not required for removing tank from engine position 5 if launch tower umbilical arm is used to transport component from stage.)

(3) Hook 9024600 from Engine Components Installer G4071, shelf 1. (Hook is required for removing tank from engine positions 1 through 4.)

(4) Component handling angle adapter 9027172 from Engine Components Installer G4071, shelf 2. (Adapter is required for removing tank from engine positions 1 through 4.)

(5) Chain-hoist 9027095 from engine components installer set 9026251.

(6) Universal joint S8 from engine components installer set 9026251.

(7) Extension bar SX-24 from engine components installer set 9026251.

(8) Hanger 9024543 from engine components installer set 9026251.

(9) Pickup adapter from engine components installer set 9026251.

(10) Components handling cart 9026253-11 from engine components installer set 9026251.

(11) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Prior to removing start tank, make sure tank has been purged in accordance with R-3825-1B since last time fuel was introduced into system.

d. Assemble track (refer to section V) around engine from which start tank is to be removed. If task is to be performed on engine position 5 (center), install heat shield support turnbuckle. (Refer to section V.) Install turntable with controls leading, and position hoist at track station 23 or 28 for engine positions 1 through 4, or track station 11 for engine position 5.

e. Install angle adapter and hook on hoist if start tank is to be removed from engine positions 1 through 4. Install pickup adapter on hook and secure with ball-lock pin. (See figure 3-6, view D.) No adapters are required for engine position 5.

f. For engine positions 1 through 4, install sling on start tank, connect sling to pickup adapter on hoist, and secure with ball-lock pin.

g. Remove STDV (paragraph 3-266).

h. Disconnect electrical connector (paragraph 3-30) P123.

hA. If start tank is to be replaced, remove start tank gas temperature transducer (TFT1). (Refer to paragraph 3-134.)

i. Remove bolts, washers, and nuts that secure vent line bracket to support.

j. Remove screw, washer, and nut that secure control line clamp to bracket.

k. Cut lockwire and remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal.

l. Install clean protective closures (paragraph 3-258) on start tank and vent-and-relief valve.

m. Temporarily reposition and secure start tank vent-and-relief valve to provide lateral access for removal of start tank.

n. If start tank is being removed from engine position 5, connect handler to STDV port on start tank with twist socket on bottom of start tank and torque captive bolts to 25 ±5 in-lb. Otherwise, install closures on all open ports.

o. For engine position 5, connect boom to handler and secure with ball-lock pin.

p. Cut lockwire and remove bolts and washers that secure start tank support-and-fill valve to tank. Remove seal. Protect open ports and sealing surfaces of tank and support-and-fill valve.

q. Remove electrical harness support clamps, as required, to gain access to helium cover attach bolts.

r. Support tank, cut lockwire, and remove bolts and washers that secure helium cover to start tank. Remove bracket. Protect open ports and sealing surfaces of tank and helium cover.

s. Remove bolt, washers, and pin that secure strut and link to mounting bracket located at STDV.

CAUTION

Flanges must be separated carefully to prevent damage to sealing surfaces.

- The start tank must be moved directly away from the helium cover to prevent damage to the tube extending from the helium cover.

t. Slowly move start tank (89 pounds) directly away from helium cover (remove helium cover seal), using care not to damage sealing surfaces and tube extending from helium cover into start tank. Tube extends into start tank 3 inches.

u. Remove protective material from start tank ports, and install clean protective closures (paragraph 3-258) on all open ports.

v. Remove protective material from support-and-fill valve and helium cover and install clean protective closures (paragraph 3-258).

w. Make sure start tank is clear of engine; then remove tank from engine area.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps y through ag; otherwise, omit step x.

x. Using hoist, transfer start tank through stage access door and lower onto component handling cart. Remove handler if installed, and install closure. Remove sling if installed.

y. Place hanger in an accessible area near stage access door.

z. Using hoist, transfer start tank near hanger.

aa. If handler 9026189 is installed on start tank, install sling 9022985 on start tank. Position sling so that start tank can be suspended from hanger. Attach pickup adapter to hanger and secure with ball-lock pin.

ab. Adjust hoist so that pickup adapter engages hanger clevis. If handler is installed, connect sling lifting ring to pickup adapter. Secure with ball-lock pin.

ac. Remove hoist from pickup adapter. If handler is installed, remove hoist from handler.

ad. Remove hook and angle adapter from hoist (if installed), and install chain-hoist.

ae. Attach chain-hoist hook to sling lifting ring. Using hoist, raise start tank and disconnect start tank sling from pickup adapter.

af. If handler is installed, remove handler and install closure.

ag. Using hoist, move start tank through stage access door and lower to component handling cart.

3-173. REMOVING INTEGRAL HYDROGEN-HELIUM START TANK (STACKED SIVB STAGE). (See figure 3-43.)

a. Obtain the following:

(1) Start tank sling 9022985

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Before removing start tank, make sure tank has been purged in accordance with R-3825-1B since last time fuel was introduced into system.

d. Assemble track. (Refer to section V to assemble track as required for applicable stage.) Install turntable on track with controls leading.

e. Install hook on hoist and secure with ball-lock pin. (See figure 3-6, view A.)

f. Remove STDV (paragraph 3-266).

g. Disconnect electrical connector (paragraph 3-30) P123.

gA. If start tank is to be replaced, remove start tank gas temperature transducer (TFT1). (Refer to paragraph 3-134.)

h. Remove bolts, washers, and nuts that secure vent line bracket to support.

i. Remove screw, washer, and nut that secure control line clamp to bracket.

j. Cut lockwire and remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal.

k. Install clean protective closures (paragraph 3-258) on start tank and vent-and-relief valve.

l. Temporarily reposition and secure start tank vent-and-relief valve to provide lateral access for removal of start tank.

m. Install sling on start tank and connect sling to hook on hoist. Secure hook latch with ball-lock pin.

n. Cut lockwire and remove bolts and washers that secure start tank support-and-fill valve to tank. Remove seal. Protect open ports and sealing surfaces of tank and support-and-fill valve.

o. Remove electrical harness support clamps, as required, to gain access to helium cover attach bolts.

p. Cut lockwire and remove bolts and washers that secure helium cover to start tank. Remove bracket. Protect open ports and sealing surfaces of tank and helium cover.

q. Remove bolt, washers, and pin that secure strut and link to mounting bracket located at STDV.

CAUTION

Flanges must be separated carefully to prevent damage to sealing surfaces.

- The start tank must be moved directly away from the helium cover to prevent damage to the tube extending from the helium cover.

r. Slowly move start tank (89 pounds) directly away from helium cover (remove helium cover seal), using care not to damage sealing surfaces and tube extending from helium cover into start tank. Tube extends into start tank 3 inches.

s. Remove protective material from start tank ports, and install clean protective closures (paragraph 3-258) on all open ports.

t. Remove protective material from support-and-fill valve and helium cover and install clean protective closures (paragraph 3-258).

u. Make sure start tank is clear of engine; then, using hoist, move start tank to an accessible area near stage access door.

v. Using sling, remove start tank from hoist and manually carry start tank from stage.

3-174. INSTALLING INTEGRAL HYDROGEN-HELIUM START TANK (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-43.)

a. Obtain start tank installer 9016783-11 (used when engine is in Engine Handler G4064).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257) from all ports on integral hydrogen-helium start tank.

d. Make sure start tank is free of damage, threads in parent metal and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

e. Inspect and clean start tank as follows:

(1) Visually inspect interior of tank for any foreign particles. Insert only oxidizer-clean equipment into tank.

(2) Do not nick or scratch start tank sealing flange or any surface inside of start tank.

(3) If foreign particles are found inside start tank, proceed to substep 4. If no foreign particles are found inside start tank; proceed to step f.

(4) Obtain a vacuum cleaner with an oxidizer-clean extension long enough to reach bottom of start tank.

(5) Install a piece of oxidizer-clean Tygon tubing on vacuum cleaner extension to prevent nicking or scratching any surface inside of start tank.

(6) Secure Tygon tubing to vacuum cleaner extension to prevent tubing from coming off of extension inside of start tank.

(7) Remove all foreign particles from inside of start tank.

f. Remove protective closures (paragraph 3-257) from helium cover, vent-and-relief valve, and support-and-fill valve. Make sure cover and valves are clean, free of damage, and OK to install. Protect ports and sealing surfaces of these components and start tank.

g. Install start tank installer 9016783-11 on forward end of Engine Handler G4064.

h. Place start tank (89 pounds) on dolly; then lower dolly to lowest position and carefully roll start tank into position under engine.

i. Raise start tank into position on helium cover by turning knurled adjustment nuts on dolly.

j. Remove protective material from start tank and helium cover; then secure start tank with seal to helium cover with bolts and washers. Position electrical support bracket under bolts and washers. Torque bolts to 147-163 in-lb and safetywire.

k. Attach strut and link to mounting bracket, located at STDV flange, with pin, washers, and bolt. Torque bolt to 48-52 in-lb.

l. Install electrical harness support clamps that were removed to gain access to helium cover attach bolts.

m. Remove protective material and position support-and-fill valve, seal, and bracket on tank flange. Secure with bolts and washers. Torque bolts to 253-279 in-lb and safetywire.

n. Remove protective material and position vent-and-relief valve and seal on tank flange. Secure with bolts and washers. Torque bolts to 114-126 in-lb and safetywire.

o. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 in-lb.

p. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 in-lb.

q. Install STDV (paragraph 3-267).

qA. If start tank was replaced, install start tank gas temperature transducer (TFT1). (Refer to paragraph 3-135.)

r. Connect electrical connector (paragraph 3-31) P123.

s. Lower dolly to lowest position and carefully roll clear of engine.

t. Remove start tank installer 9016783-11 and dolly.

u. Refer to section IV for test requirements.

3-175. INSTALLING INTEGRAL HYDROGEN-HELIUM START TANK (STACKED SII STAGE). (See figure 3-43.)

a. Obtain the following: (Items 5 through 9 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Start tank handler 9026189 from Engine Components Installer G4071, shelf 3. (Handler is required only for installing tank on engine position 5.)

(2) Start tank sling 9022985. (Sling is not required for installing tank on engine position 5 if launch tower umbilical arm is used to transport component from stage.)

(3) Adapter 9027172 from Engine Components Installer G4071, shelf 2. (Adapter is required only for installing tank on engine positions 1 through 4.)

(4) Hook 9024600 from Engine Components Installer G4071, shelf 3. (Hook is required only for installing tank on engine positions 1 through 4.)

(5) Chain-hoist 9027095 from engine components installer set 9026251

(6) Universal joint S8 from engine components installer set 9026251

(7) Extension bar SX-24 from engine components installer set 9026251

(8) Hanger 9024543 from engine components installer set 9026251

(9) Pickup adapter 9024547 from engine components installer set 9026251

(10) Cart 9026253-11 from engine components installer set 9026251

(11) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Inspect and clean start tank as follows:

(1) Remove protective closure (paragraph 3-257) from start tank opening, and visually inspect interior of tank for any foreign particles. Insert only oxidizer-clean equipment into tank.

(2) Do not nick or scratch start tank sealing flange or any surface inside of start tank.

(3) If foreign particles are found inside start tank, proceed to substep 4. If no foreign particles are found inside start tank, proceed to step d.

(4) Obtain a vacuum cleaner with an oxidizer-clean extension long enough to reach bottom of start tank.

(5) Install a piece of oxidizer-clean Tygon tubing on vacuum cleaner extension to prevent nicking or scratching any surface inside of start tank.

(6) Secure Tygon tubing to vacuum cleaner extension to prevent it from coming off of extension inside of start tank.

(7) Remove all foreign particles from inside of start tank.

d. Remove remaining protective closures (paragraph 3-257) from start tank. Make sure tank threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open tank ports and sealing surfaces.

e. Remove protective closures (paragraph 3-257) from helium cover, vent-and-relief valve, and support-and-fill valve. Make sure cover and valves are clean, free of damage, and OK to install. Protect ports and sealing surfaces.

f. Install sling 9022985 on start tank for engine positions 1 through 4. Orient start tank (89 pounds) as installed on engine in sling.

g. Install handler 9026189 on start tank for engine position 5, position handler on discharge valve flange of start tank, and aline handler with strut bolthole on flange with hoist socket

on bottom side of start tank. Install bolts and torque to 20-30 in-lb.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps k through s; otherwise, omit steps h through j.

h. If start tank is to be installed on engine positions 1 through 4, install angle adapter and hook on boom. (See figure 3-6, view E.) Adapters are not required for engine position 5.

i. Connect hoist to handler or sling and secure with ball-lock pin.

j. Using hoist, move start tank through stage access door.

k. Install chain-hoist on hoist.

l. If handler is installed on start tank, install sling 9022985 on start tank.

m. Lower chain-hoist hook and attach to sling lifting ring.

n. Using hoist, raise and move start tank through stage access door to hanger.

o. Using hoist, position start tank so that sling lifting ring engages pickup adapter on hanger. Secure with ball-lock pin.

p. Remove chain-hoist-hook from sling. Remove chain-hoist from hoist.

q. If start tank is to be installed on engine positions 1 through 4, install angle adapter and hook on boom. (See figure 3-6, view E.) Adapters are not required for engine position 5.

r. Connect hoist to handler or pickup adapter. Secure with ball-lock pin.

s. Raise start tank and remove ball-lock pin. Remove sling if start tank is attached to handler.

t. Position hoist at track station 23 or 28 for engine positions 1 through 4, or track station 11 for engine position 5.

u. Using hoist, move start tank to engine position.

v. Remove protective material and place seal on helium cover.

CAUTION

Flanges must be mated carefully to prevent damage to the seal and/or sealing surfaces.

w. Using hoist, guide start tank on to helium cover using care not to damage seal or sealing surfaces.

x. Secure start tank to helium cover with bolts and washers. Position electrical support bracket under bolts and washers. Torque bolts to 147-163 in-lb and safetywire.

y. Attach strut and link to mounting bracket, located at STDV flange, with pin, washers, and bolt. Torque bolt to 48-52 in-lb.

z. Install electrical harness support clamps removed to gain access to helium cover.

aa. Remove handler or sling from start tank.

ab. Disassemble track. (Refer to section V.)

ac. Remove protective material, position support-and-fill valve, seal, and bracket on tank flange, and secure with bolts and washers. Torque bolts to 253-279 in-lb and safetywire.

ad. Remove protective material, position vent-and-relief valve and seal on tank flange, and secure with bolts and washers. Torque bolts to 114-126 in-lb and safetywire.

ae. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 in-lb.

af. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 in-lb.

ag. Install STDV (paragraph 3-267).

agA. If start tank was replaced, install start tank gas temperature transducer (TFT1). (Refer to paragraph 3-135.)

ah. Connect electrical connector (paragraph 3-31) P123.

ai. Refer to section IV for test requirements.

3-176. INSTALLING INTEGRAL HYDROGEN-HELIUM START TANK (STACKED SIVB STAGE). (See figure 3-43.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following:

(1) Start tank sling 9022985

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Install hook on hoist, and locate hoist in an accessible area near stage access.

d. Install sling on start tank, and manually carry start tank (89 pounds) into stage. Install sling on hoist, and secure hook latch with ball-lock pin. Step e may be accomplished prior to bringing the start tank into the stage.

e. Inspect and clean start tank as follows:

(1) Remove protective closure (paragraph 3-257) from start tank opening and visually inspect interior of tank for any foreign particles. Insert only oxidizer-clean equipment into tank.

(2) Do not nick or scratch start tank sealing flange or any surface inside of start tank.

(3) If foreign particles are found inside start tank, proceed to substep 4. If no foreign particles are found inside start tank, proceed to step f.

(4) Obtain a vacuum cleaner with an oxidizer-clean extension long enough to reach bottom of start tank.

(5) Install a piece of oxidizer-clean Tygon tubing on vacuum cleaner extension to prevent nicking or scratching any surface inside of start tank.

(6) Secure Tygon tubing to vacuum cleaner extension to prevent tubing from coming off of extension inside of start tank.

(7) Remove all foreign particles from inside of start tank.

f. Remove remaining protective closures (paragraph 3-257) from start tank. Make sure tank, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open tank ports and sealing surfaces.

g. Remove protective closures (paragraph 3-257) from helium cover, vent-and-relief valve, and support-and-fill valve. Make sure cover and valves are clean, free of damage, and OK to install. Protect ports and sealing surfaces.

h. Orient start tank in sling as installed on engine.

i. Using hoist, move start tank to engine position.

j. Remove protective material and place seal on helium cover.

CAUTION

Flanges must be mated carefully to prevent damage to the seal and/or sealing surfaces.

k. Using hoist, guide start tank on to helium cover using care not to damage seal or sealing surfaces.

l. Secure start tank to helium cover with bolts and washers. Position electrical support bracket under bolts and washers. Torque bolts to 147-163 in-lb and safetywire.

m. Attach strut and link to mounting bracket, located at STDV flange, with pin, washers, and bolt. Torque bolt to 48-52 in-lb.

n. Install electrical harness support clamps removed to gain access to helium cover.

o. Remove sling from start tank.

p. Disassemble track. (Refer to section V.)

q. Remove protective material, position support-and-fill valve, seal, and bracket on tank flange, and secure with bolts and washers. Torque bolts to 253-279 in-lb and safetywire.

r. Remove protective material, position vent-and-relief valve and seal on tank flange, and secure with bolts and washers. Torque bolts to 114-126 in-lb and safetywire.

s. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 in-lb.

t. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 in-lb.

u. Install STDV (paragraph 3-267).

uA. If start tank was replaced, install start tank gas temperature transducer (TFT1). (Refer to paragraph 3-135.)

v. Connect electrical connector (paragraph 3-31) P123.

w. Refer to section IV for test requirements.

3-177. MAIN FUEL INJECTION TEMPERATURE (CONTROL) TRANSDUCER.

3-178. REMOVING MAIN FUEL INJECTION TEMPERATURE (CONTROL)TRANSDUCER. (See figure 3-44.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (paragraph 3-30) P22 (13).

c. Remove nut (12), washer (11), bolt (10), washer (9), nuts (8), washers (7), bolts (6, 5), washers (4), bracket (3), transducer (2), and seal (1).

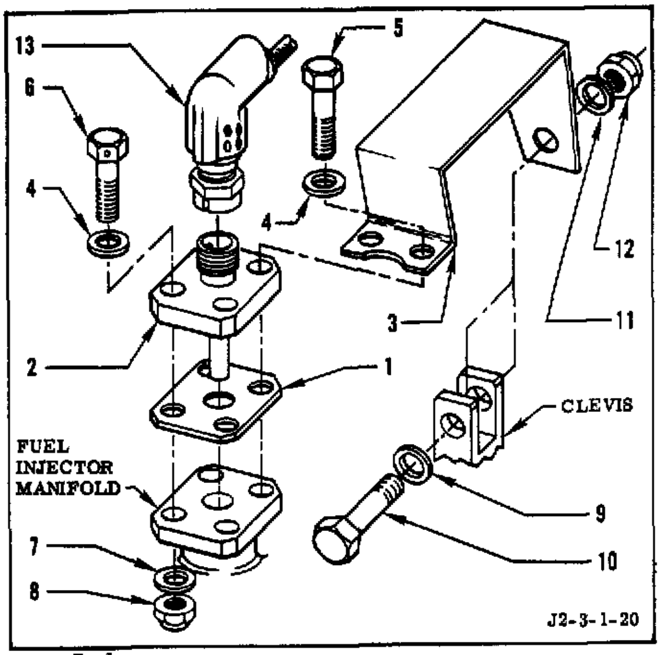
d. Install clean protective closures (paragraph 3-258) on transducer and fuel injector manifold port.

3-179. INSTALLING MAIN FUEL INJECTION TEMPERATURE (CONTROL) TRANSDUCER. (See figure 3-44.)

a. If transducer is being replaced, verify that temperature transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from transducer and fuel injector manifold port. Make sure transducer and manifold port mating surface are clean and free of damage.



Index No.	Description
1	Seal
2	Temperature transducer
3	Bracket 502848
4	Washer RD153-5003-0004
5	Bolt RD111-1010-3419
6	Bolt RD111-1009-3717
7	Washer LD153-0010-0009
8	Nut
9	Washer RD153-5004-0006
10	Bolt
11	Washer RD153-1002-0006
12	Nut
13	Electrical connector P22

Figure 3-44. Main Fuel Injection Temperature (Control) Transducer

c. Wipe transducer and boss sealing surfaces with a clean, lint-free cloth, and make sure sealing surfaces are free of nicks, scratches, deposits, or other imperfections that would impair sealing.

d. Place seal (1) over stem of transducer (2); insert and position transducer in boss to aline transducer connector key with electrical connector P22 keyway; then install bracket (3), washers (4), bolts (5, 6), washers (7), nuts (8), washer (9), bolt (10), washer (11), and nut (12).

e. Cross-torque bolts (5, 6) to 48-53 in-lb.

f. Torque bolt (10) to 60-85 in-lb.

g. Connect electrical connector (paragraph 3-31) P22 (13) to transducer (2).

h. Refer to section IV for test requirements.

3-180. MAIN FUEL INJECTION TEMPERATURE TRANSDUCER.

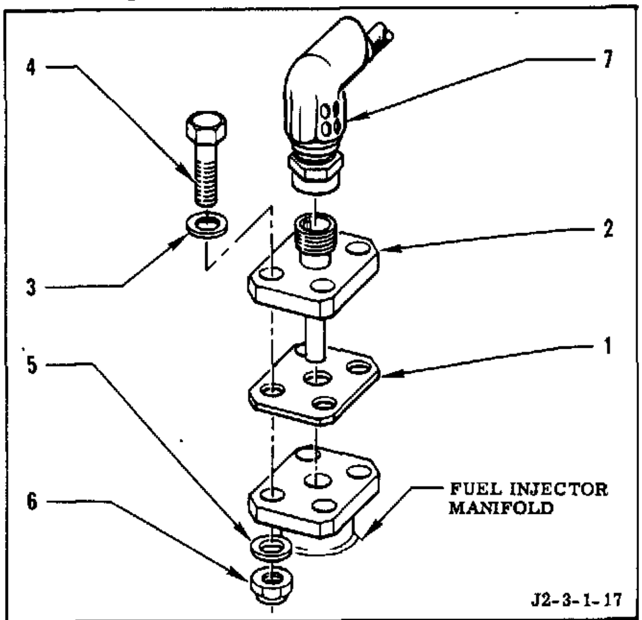
3-181. REMOVING MAIN FUEL INJECTION TEMPERATURE TRANSDUCER. (See figure 3-45.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (paragraph 3-30) P131 (7).

c. Remove nuts (6), washers (5), bolts (4), washers (3), transducer (2), and seal (1).

d. Install clean protective closures (paragraph 3-258) on transducer and fuel injector manifold port.



Index No.	Description
1	Seal
2	Temperature transducer
3	Washer RD153-5003-0004
4	Bolt
5	Washer LD153-0010-0009
6	Nut
7	Electrical connector P131

Figure 3-45. Main Fuel Injection Temperature Transducer

3-182. INSTALLING MAIN FUEL INJECTION TEMPERATURE TRANSDUCER. (See figure 3-45.)

a. If transducer is being replaced, verify that temperature transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from transducer and fuel injector manifold. Make sure transducer and manifold mating surfaces are clean and free of damage.

c. Wipe transducer and boss sealing surfaces with a clean, lint-free cloth, and make sure sealing surfaces are free of nicks, scratches, deposits, or other imperfections that would impair sealing.

d. Place seal (1) over stem of transducer (2); insert and position seal and transducer in boss to aline transducer connector key with electrical connector P131 keyway; then install washers (3), bolts (4), washers (5), and nuts (6).

e. Cross-torque bolts (4) to 48-53 in-lb.

f. Connect electrical connector (paragraph 3-31) P131 (7) to transducer (2).

g. Refer to section IV for test requirements.

3-183. MAIN FUEL VALVE.

3-184. REMOVING MAIN FUEL VALVE. (See figure 3-46.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when MFV is removed from engines incorporating MD224 or MD225 change, to prevent damage to insulation.

b. Disconnect electrical connector (paragraph 3-30) P114.

c. Remove bolts, washers, and bracket on ring that holds STDV control line to MFV, and remove seal. Protect ports and sealing surfaces.

d. Remove bolts and washers on ring that holds sequence inlet line and remove seal. Protect ports and sealing surfaces.

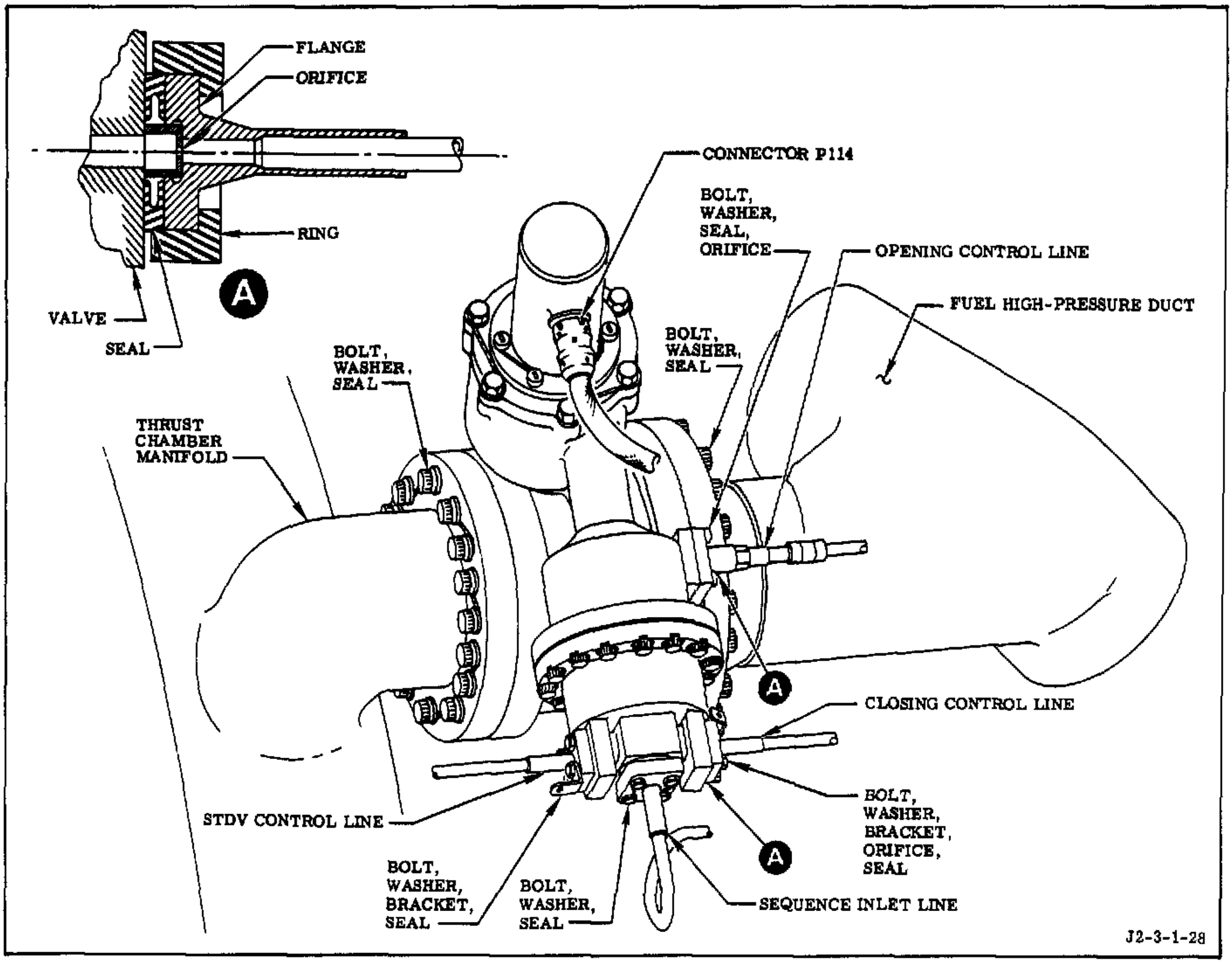


Figure 3-46. Main Fuel Valve

e. Remove bolts and washers on ring that holds opening control line, and remove seal and orifice. (Orifice must be retained for reinstallation.) Protect ports and sealing surfaces.

f. Remove bolts, washers, and bracket on ring that holds closing control line to MFV, and remove seal and orifice. (Orifice must be retained for reinstallation.) Protect ports and sealing surfaces.

g. Loosen all bolts on fuel high-pressure duct flange and thrust chamber manifold flange. Remove all bolts and washers except top bolt and washer from both flanges.

h. Support MFV, remove the one remaining bolt from duct flange, and carefully remove seal.

i. Remove remaining bolt and washers from top of thrust chamber manifold flange side, and carefully remove valve and seal. Note position of valve for reinstallation.

j. Remove all protective material from MFV and engine ports; install clean protective closures (paragraph 3-258).

3-185. INSTALLING MAIN FUEL VALVE. (See figure 3-46.)

a. *When performing this procedure,* observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when MFV is installed on engines incorporating MD224 or MD225 change, to prevent damage to insulation.

b. Remove protective closures (paragraph 3-257) from MFV. Make sure MFV, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

c. Protect sealing surfaces of MFV.

d. Remove protective closures (paragraph 3-257) from engine ports. Make sure mating surfaces are clean and free of damage. Protect sealing surfaces of engine ports.

e. Remove protective material from thrust chamber manifold, fuel high-pressure duct and respective mating surfaces, and MFV.

f. Position MFV and seal on thrust chamber manifold and install a sufficient number of bolts and washers (fingertight) to hold valve and seal in position.

g. Install seal between fuel high-pressure duct and MFV. Install remaining bolts and washers in both flanges.

h. Torque thrust chamber manifold flange bolts to 479-529 in-lb and safetywire.

i. Torque fuel high-pressure duct flange bolts to 605-669 in-lb and safetywire.

j. Remove protective material from STDV control line flange and port on MFV. Install seal, position ring over flange, and install bracket, bolts, and washers. Torque bolts to 41-45 in-lb and safetywire.

k. Remove protective material from sequence inlet line flange and port on MFV. Install seal, position ring over flange, and install bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

l. Remove protective material from opening control line flange and port on MFV. Install seal, orifice (same orifice that was removed) with cupped side of orifice toward MFV, position ring over flange, and install bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

m. Remove protective material from closing control line flange and port on MFV. Install seal, orifice (same orifice that was removed) with cupped side of orifice toward MFV, position ring over flange, and install bracket, bolts, and washers. Torque bolts to 41-45 in-lb and safetywire.

n. Connect electrical connector (paragraph 3-31) P114.

o. If MFV is replaced on engines incorporating MD224 or MD225 change, insulate MFV (paragraph 3-166).

p. Refer to section IV for test requirements.

3-185A. MAIN FUEL VALVE POSITION INDICATOR.

3-185B. REMOVING MAIN FUEL VALVE POSITION INDICATOR. (See figure 3-46A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

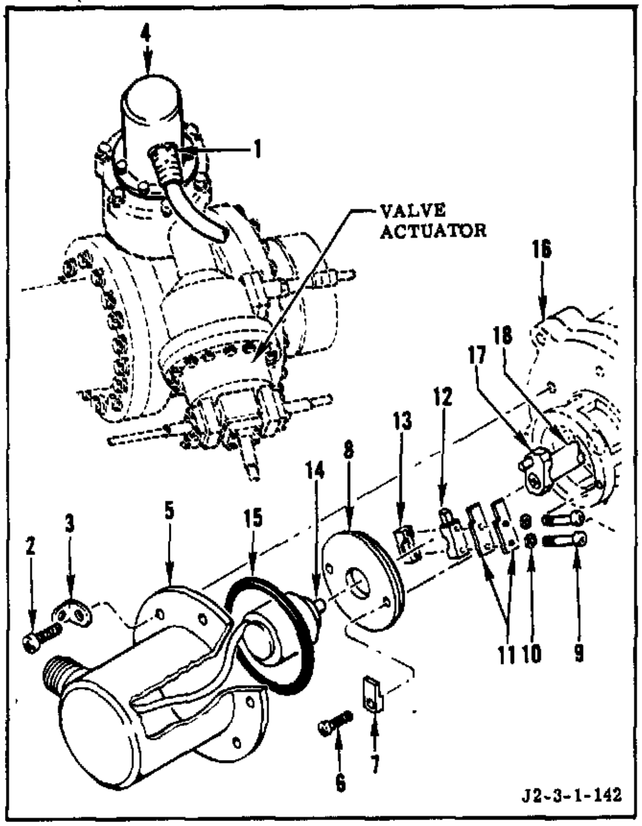
b. Before performing steps c and d, make sure MFV is in fully closed position.

c. Energize helium control valve, and pressurize engine helium tank with helium to 225-250 psig.

d. Depressurize system by decreasing pressure to helium tank to zero, allowing pressure to vent from helium tank, and deenergizing helium control valve.

e. Disconnect electrical connector (paragraph 3-30) P114 (1).

f. Remove screws (2) and lug (3), and separate housing (5) from mount (16). Care must be exercised to prevent damage to wiring.



Index No.	Description
1	Electrical Connector P114
2	Screw
3	Lug
4	Indicator
5	Housing
6	Screw
7	Clip
8	Base
9	Screw
10	Washer
11	Spring
12	Arm
13	Clamp
14	Shaft
15	Packing
16	Mount
17	Arm
18	Shaft

Figure 3-46A. Main Fuel Valve Position Indicator

g. Remove screws (6) and clips (7).

h. Holding housing (5) to prevent undue strain on wiring of potentiometer, remove items index numbered 5 and 8 through 13 from end of shaft (18) as an assembly. Remove packing (15).

i. Remove screws (9), washers (10), springs (11), arm (12), and clamp (13) from shaft (14).

j. Protect and retain all items except packing (15) for reinstallation on MFV.

k. If indicator (4) is not immediately reinstalled, protect MFV and indicator with clean protective material.

3-185C. INSTALLING MAIN FUEL VALVE POSITION INDICATOR. (See figure 3-46A.)

a. If position indicator is being replaced, verify that position transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective material from MFV and from indicator (4). Make sure MFV and indicator are clean and free of damage.

c. Remove protective material from all items that were retained for reinstallation. Make sure all items are clean and free of damage.

d. Install base (8) in place over shaft (14).

e. Assemble 2 springs (11), arm (12), and clamp (13) with 2 washers (10) and 2 screws (9) and install on shaft (14) with bar of clamp (13) against flat on shaft and in position shown. Torque screws to 30-38 in-oz and safetywire.

f. Install packing (15) on mount (16).

g. Install base (8) on mount (16), and at same time match slot in arm assembly on shaft (14) with pin of arm (17). Do not allow undue

strain on wiring of potentiometer while assembling components. Secure in position with clips (7) and screws (6). Tighten screws (6) finger-tight.

h. Adjust indicator (4) as follows:

(1) Connect Wheatstone bridge to pins A and B of electrical connector J114. With MFV in normally closed position, rotate potentiometer until a resistance of 500 ±10 ohms is obtained. Do not allow undue strain on wiring of potentiometer while adjusting potentiometer.

(2) Torque screws (6) to 197-241 in-oz to secure base. Reverify resistance of 500 ±10 ohms; then safetywire screws (6).

i. Install housing (5) positioning electrical connector P114 (1) and lug (3) on same axis with valve actuator. Install screws (2); torque screws to 27-33 in-lb and safetywire.

j. Connect electrical connector (paragraph 3-31) P114 (1).

k. Refer to section IV for test requirements.

3-186. MAIN OXIDIZER VALVE.

3-187. REMOVING MAIN OXIDIZER VALVE. (See figure 3-47.)

a. Obtain the following:

(1) Adapter T-5044412

(2) Adapter T-5041554

CAUTION

Care must be taken throughout this procedure to prevent damage to the ASI line.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Disconnect electrical connectors paragraph 3-30) P115 and P120.

d. Remove bolts and washers that secure ASI oxidizer line to ASI valve; remove seal, and protect open ports and sealing surfaces.

e. Remove bolts and washers from opening port flange on ASI valve; remove seal, and protect open ports and sealing surfaces.

f. Remove bolts and washers from closing port flange on ASI valve; remove seal, and protect open ports and sealing surfaces.

g. Remove bolts, washers, and bracket from control port flange on MOV; then remove seal and orifice. Retain orifice for reinstallation. Protect open ports and sealing surfaces.

h. Remove bolts and washers from prestage inlet port line flange to sequence control valve; remove seal, and protect open ports and sealing surfaces.

i. Remove bolts and washers from inlet port flange on sequence control valve; remove seal, and protect open ports and sealing surfaces.

j. Remove bolts and washers from outlet port flange on sequence control valve; remove manifold adapter and seals from each side, and protect open ports and sealing surfaces.

k. Remove bolts and washers from MOV closing port line flange; remove seal, and protect open ports and sealing surfaces.

l. Cut GG pressure equalization line. (Refer to section VI for tube cutting requirements.) Protect open lines.

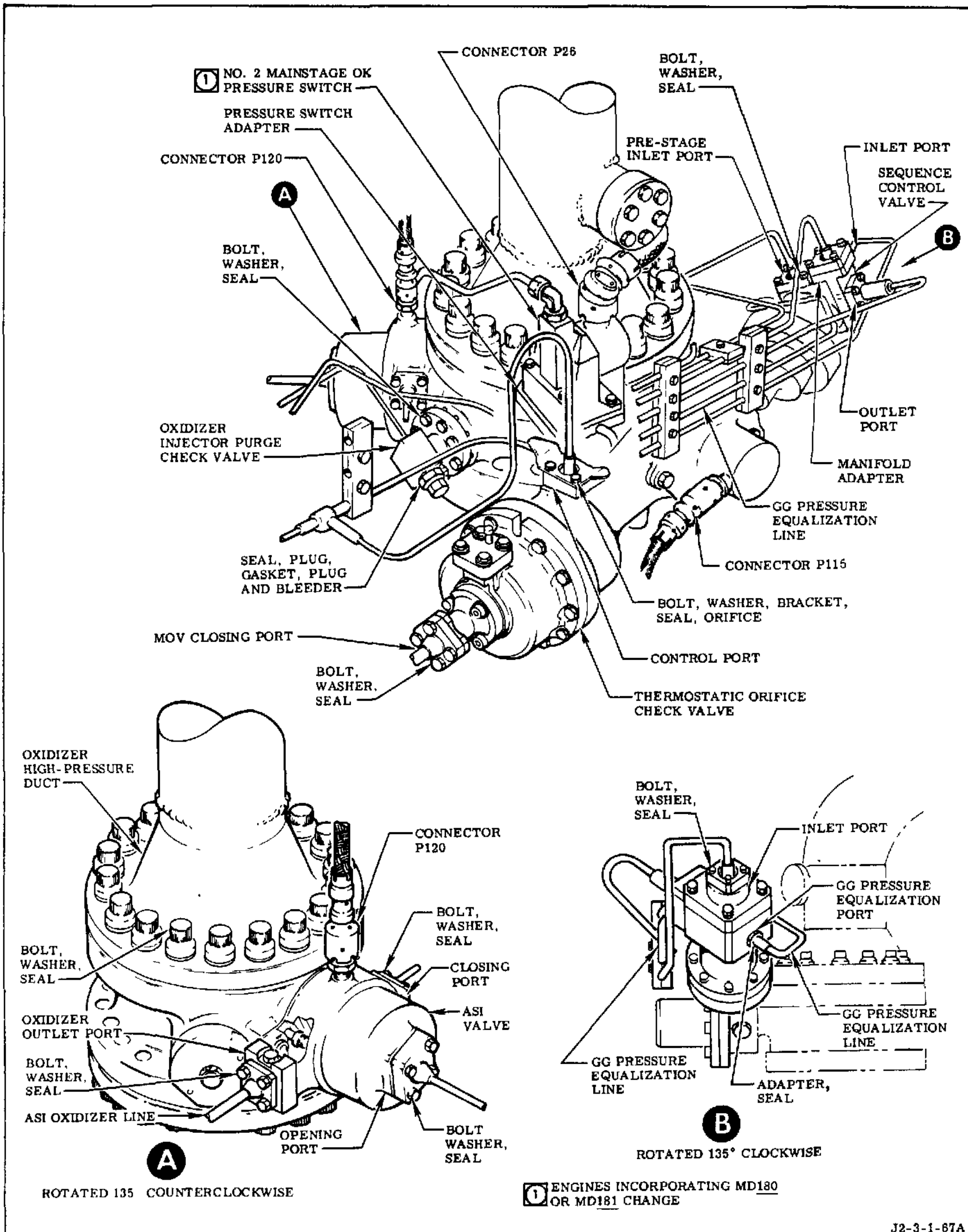


Figure 3-47. Main Oxidizer Valve

lA. Remove plug and bleeder, gasket, plug, and seal from oxidizer injector purge check valve. Retain plugs for reinstallation. Protect open port.

m. Remove bolts and washers from oxidizer injector purge check valve. Do not remove seal at this time.

n. On engines incorporating MD180 or MD181 change, remove No. 2 mainstage OK pressure switch (paragraph 3-192).

o. Remove 2 bolts that secure pressure switch adapter to oxidizer high-pressure duct outlet flange.

p. Remove 4 bolts that secure pressure switch adapter to oxidizer injector dome inlet flange; remove adapter seal, and protect open ports and sealing surfaces.

q. Remove bolts and washers that secure MOV to oxidizer high-pressure duct.

r. Carefully lift high-pressure duct to provide clearance for seal; remove seal, and protect open ports and sealing surfaces.

s. Using adapter T-5044412 (where necessary for access), remove bolts and washers that secure MOV to oxidizer injector dome.

t. Lift MOV to prevent damage to seal; remove seal, and protect open ports and sealing surfaces.

u. Carefully remove MOV, and remove seal from oxidizer injector purge check valve.

v. Remove all protective material from MOV and engine ports; install clean protective closures (paragraph 3-258).

w. If MOV is to be replaced, using adapter T-5041554 (where necessary for access), remove bolts and washers that secure ASI valve to MOV. Remove valve and seal, and retain ASI valve for installation on new MOV. Install clean protective closures (paragraph 3-258) on all open ports.

3-188. INSTALLING MAIN OXIDIZER VALVE. (See figure 3-47.)

a. Obtain the following:

(1) Adapter T-5044412.

(2) Adapter T-5041554.

CAUTION

Care must be taken throughout this procedure to prevent damage to the ASI line.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure MOV, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

NOTE

If the MOV is being replaced, proceed to step d. If the MOV is not being replaced, proceed to step f.

- The ASI valve is installed on the MOV at this time for ease of installation.

d. Make sure ASI valve is clean, free of damage, and OK to install.

e. Remove protective material from mating flanges of ASI valve and from MOV, and install ASI valve on MOV with seal, bolts, and washers. Using adapter T-5041554 (where necessary for access), torque bolts to 48-52 in-lb and safetywire.

f. If MOV was replaced, remove protective closure from GG pressure equalization line port in sequence control valve, install new seal and adapter in port, and torque to 47-53 in-lb.

CAUTION

Installing the purge check valve with a loose housing will result in leakage between the MOV and the check valve.

fA. Remove protective material from oxidizer injector purge check valve, and torque check valve housing to 25-50 in-lb. Install seal on check valve.

g. Position MOV on oxidizer injector dome flange; then remove protective material from MOV and dome flange.

h. Install seal; then install 2 bolts and washers opposite each other to hold seal and MOV in place.

i. Install 2 bolts that secure ASI oxidizer line bracket to injector dome inlet flange.

j. Install remainder of bolts and washers that secure MOV to injector dome flange.

k. Using adapter T-5044412 (where necessary for access), cross-torque bolts that secure MOV to 570-630 in-lb and safetywire.

l. Secure oxidizer injector purge check valve to MOV with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

lA. Remove protective material and install seal, plug, gasket, and plug and bleeder in port on oxidizer injector purge check valve. Torque plug to 66-73 in-lb and safetywire. Torque plug and bleeder to 22-28 in-lb and safetywire.

m. Remove protective material from ASI oxidizer line flange and ASI valve, and install seal.

n. Perform an ASI oxidizer line flange alinement check (figure 3-2) as follows:

(1) Mating holes in flange of oxidizer line must aline with mating holes in ASI valve within 0.250 inch.

(2) Measure gap between oxidizer line and mating flange of ASI valve. Gap must not exceed 0.400 inch.

(3) Apply hand pressure to oxidizer line until seal contacts mating surface of ASI valve. Mating surfaces of oxidizer line flange and ASI valve flange must be parallel within 0.080 inch.

(4) Apply hand pressure to oxidizer line until seal contacts mating surfaces of ASI valve. If bolts can be installed without force, rotational alinement is acceptable.

CAUTION

The oxidizer line must be supported to prevent excessive loads on the weld near the ASI injector when making alinement bends.

(5) If oxidizer line does not fall within tolerances in substeps 1 through 4, bend oxidizer line to meet requirements. Use an approved tube-bending tool, and support oxidizer line to prevent movement during alinement bending. Do not make bends within 3 inches of any tube weld.

o. When all alinement requirements of step n have been met, secure ASI oxidizer line and seal to ASI valve with bolts and washers. Torque bolts to 40-45 in-lb and safetywire.

p. Remove protective material from MOV and oxidizer high-pressure duct, install seal, and secure duct with bolts and washers. Tighten bolts fingertight. On engines incorporating MD180 or MD181 change, do not install the 2 bolts that attach No. 2 mainstage OK pressure switch adapter to oxidizer high-pressure duct outlet flange. (Position and install purge control valve bracket and purge control valve when installing MOV bolts.)

q. On engines incorporating MD180 or MD181 change, remove protective material and install seal and No. 2 mainstage OK pressure switch adapter on oxidizer injector dome inlet flange with bolts and washers. Torque bolts to 55-65 in-lb and safetywire.

r. On engines incorporating MD180 or MD181 change, secure No. 2 mainstage OK pressure switch adapter to oxidizer high-pressure duct outlet flange, with bolts (fingertight).

s. Using adapter T-5044412, cross-torque bolts that secure MOV to oxidizer high-pressure duct to 570-630 in-lb and safetywire.

t. On engines incorporating MD180 or MD181 change, install No. 2 mainstage OK pressure switch. (Refer to paragraph 3-195.)

u. Remove protective material from prestage inlet port and line flange. Install seal, bolts, and washers. Torque bolts to 41-45 in-lb and safetywire.

v. Remove protective material from inlet port and line flange. Install seal, bolts, and washers. Torque bolts to 41-45 in-lb and safetywire.

w. Remove protective material from outlet port, manifold adapter flanges, and outlet port line flange. Install manifold adapter, seals, bolts, and washers. Torque bolts to 41-45 in-lb and safetywire

x. Remove protective material from MOV closing port and line flange. Install seal, bolts, and washers. Torque bolts to 41-45 in-lb and safetywire.

y. Remove protective material from MOV control port and line flange. Install seal, orifice that was removed (with cupped side of orifice toward MOV), manifold, and bracket; then secure with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

z. Remove protective material from ASI valve closing port and line flange. Install seal, bolts, and washers. Torque bolts to 41-45 in-lb and safetywire.

aa. Remove protective material from ASI valve opening port and line flange. Install seal, bolts, and washers. Torque bolts to 41-45 in-lb.

aaA. Torque GG pressure equalization tube adapter to 50 in-lb. If adapter tube stub alines with existing line, proceed to next step. If adapter tube stub does not aline with existing line, remove and replace adapter and seal, and torque adapter to 47-53 in-lb.

ab. Remove protective material from ends of GG pressure equalization tube; then weld line. (Refer to section VI for tube welding requirements.)

ac. Connect electrical connectors (paragraph 3-31) P115 and P120.

ad. Refer to section IV for test requirements.

3-188-1. MAIN OXIDIZER VALVE FILTER HOUSING ASSEMBLY.

3-188-2. REMOVING MAIN OXIDIZER VALVE FILTER HOUSING ASSEMBLY. The filter housing assembly (housing, poppet, and spring) must be maintained as a unit. Replacement of any part requires the replacement of the complete assembly.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove electrical and line support clamps shown in figure 3-47-1.

c. Remove bolts and washers that secure MOV closing control line to MOV filter housing and remove seal from between control line and housing. See figure 3-47-2.

d. Make sure closing control line can be moved away from filter housing approximately 1-1/2 inches. Remove additional line support clamps if necessary. Approximately 1-1/2 inches clearance is required to allow removal of housing.

e. Remove bolts and washers that secure filter housing to cylinder cap and remove filter housing making sure poppet and spring are removed and retained with filter housing.

f. Remove all protective material from filter housing and cylinder cap; install clean protective closures (paragraph 3-258).

3-188-3. INSTALLING MAIN OXIDIZER VALVE FILTER HOUSING ASSEMBLY (ENGINE HORIZONTAL). The filter housing assembly (housing, poppet, and spring) must be maintained as a unit. Replacement of any part requires the replacement of the complete assembly.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

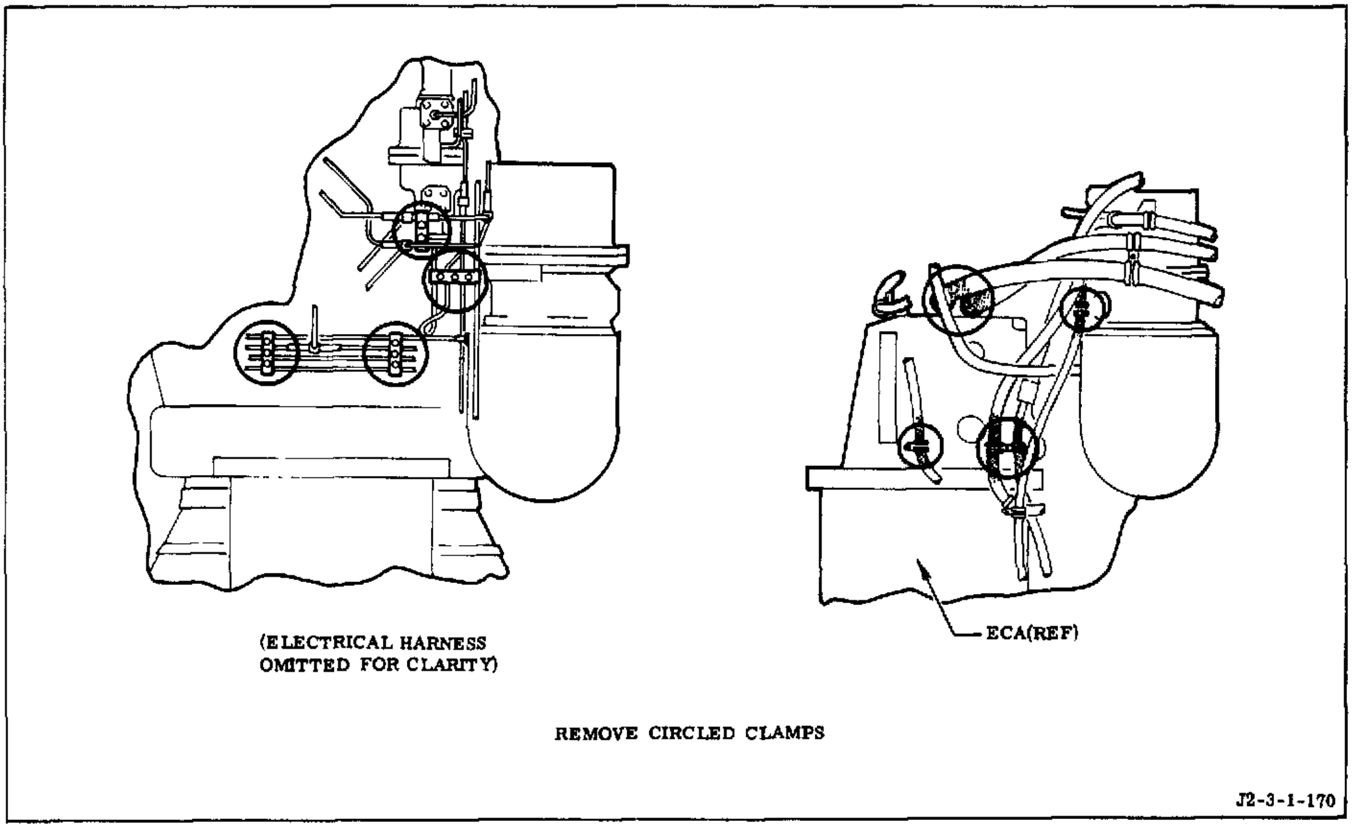


Figure 3-47-1. Clamps Requiring Removal for MOV Filter Housing Assembly Removal

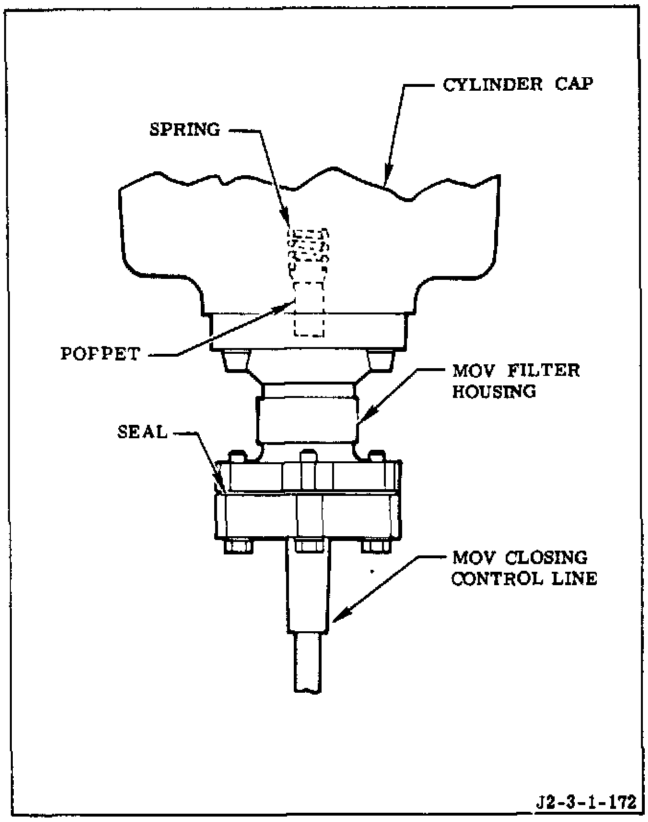


Figure 3-47-2. MOV Filter Housing Assembly Installed

b. Fabricate tools shown in figure 3-47-3.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302) or cleaning solvent (MSFC-SPEC-237), which are volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

c. Clean tools by handwiping with a clean nylon cloth wetted in cleaning compound (MIL-C-81302) or cleaning solvent (MSFC-SPEC-237).

WARNING

Compressed gas must not be used for drying or cleaning unless effective chip guarding is used and personal protection equipment is worn.

d. Rinse tools in clean compound or solvent and dry by blowing with low-pressure (less than 30 psig) gaseous nitrogen.

e. Install new seals on filter housing and hold seals in place using fabricated seal retaining tool. See figure 3-47-4.

f. Insert poppet in filter housing and hold poppet using fabricated poppet holding tool. See figure 3-47-4.

g. Install spring ID over protrusion inside cylinder cap.

CAUTION

Spring ID must engage poppet and protrusion or valve timing will be affected.

h. Position filter housing (with seals and poppet held in place) so that poppet engages spring in cylinder cap. See figure 3-47-5.

i. With full engagement of spring and poppet, remove poppet holding tool.

j. Make sure drilled passage in cylinder cap and filter housing are alined, install 2 bolts with washers to hold filter housing snugly but loose enough to permit removal of seal retaining tool.

k. Force filter housing against cylinder cap with full hand pressure and release.

l. Remove seal retaining tool and check impression on tool to make sure small seal is correctly positioned. If tool does not have a circular impression of small seal, remove filter housing and repeat procedure starting with step e, except new seals are not required unless existing seals are damaged.

m. Install remaining bolts and washers that secure filter housing to cylinder cap. Torque (section I) bolts to 72-88 in-lb and lockwire them.

n. Position closing control line on filter housing and loosely install 2 bolts and washers. Position seal on line flange and install remaining bolts and washers. Torque bolts to 41-45 in-lb and lockwire them.

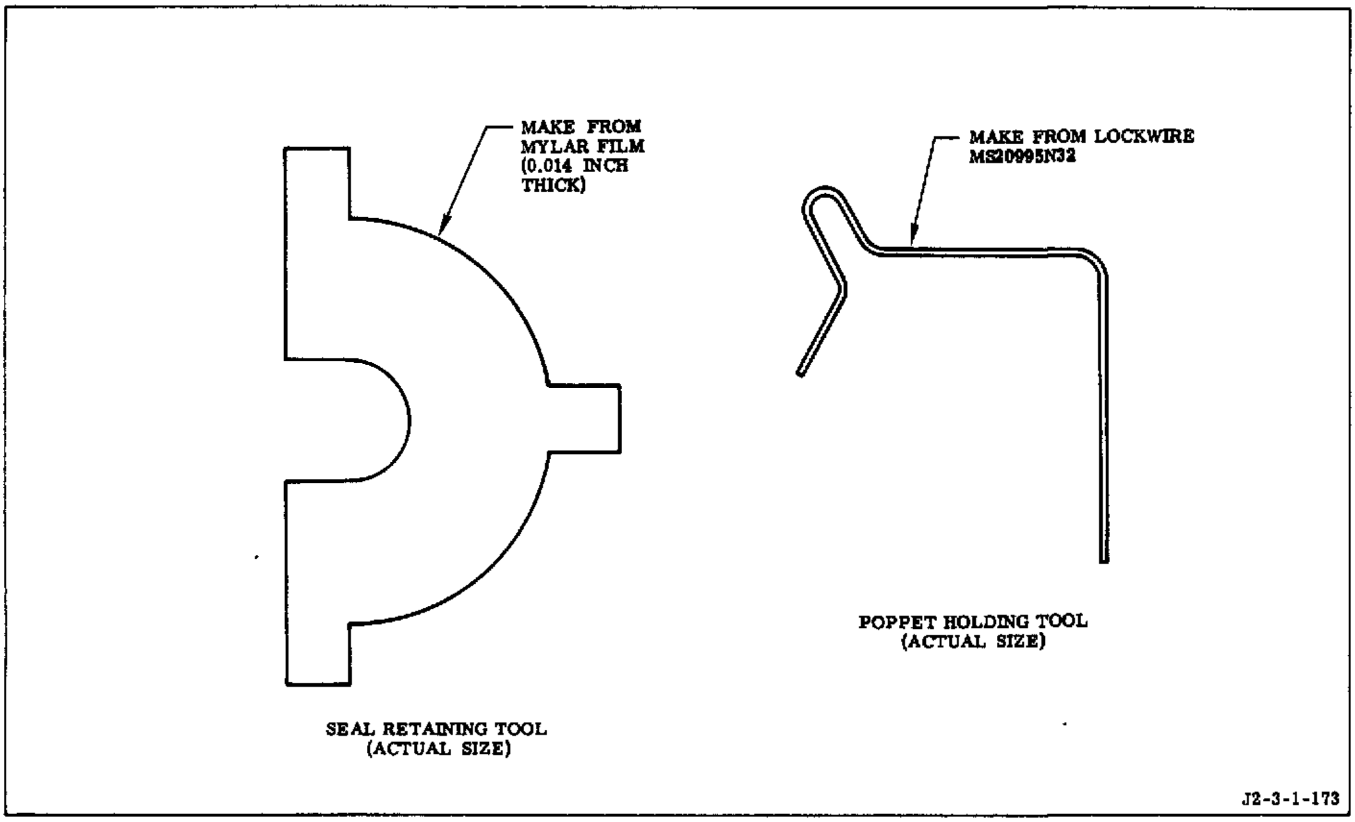


Figure 3-47-3. Tools Required for Installing MOV Filter Housing Assembly (Engine on Engine Handler)

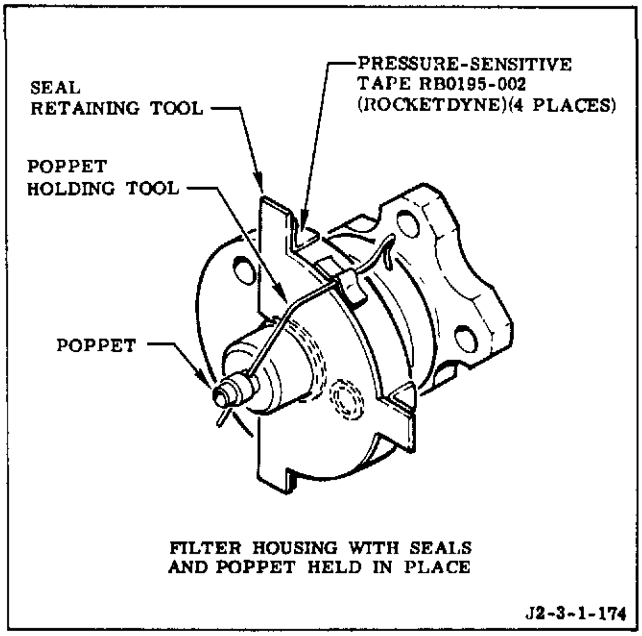


Figure 3-47-4. Filter Housing With Seals and Poppet Held in Place

o. Reinstall removed electrical and line support clamps. See figure 3-47-1. Torque screws to 24-30 in-lb.

p. Refer to section IV for test requirements.

3-188-4. INSTALLING MAIN OXIDIZER VALVE FILTER HOUSING ASSEMBLY (ENGINE VERTICAL). The filter housing assembly (housing, poppet, and spring) must be maintained as a unit. Replacement of any part requires the replacement of the complete assembly.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Install new seals on filter housing.

c. Insert poppet in filter housing and install spring on poppet.

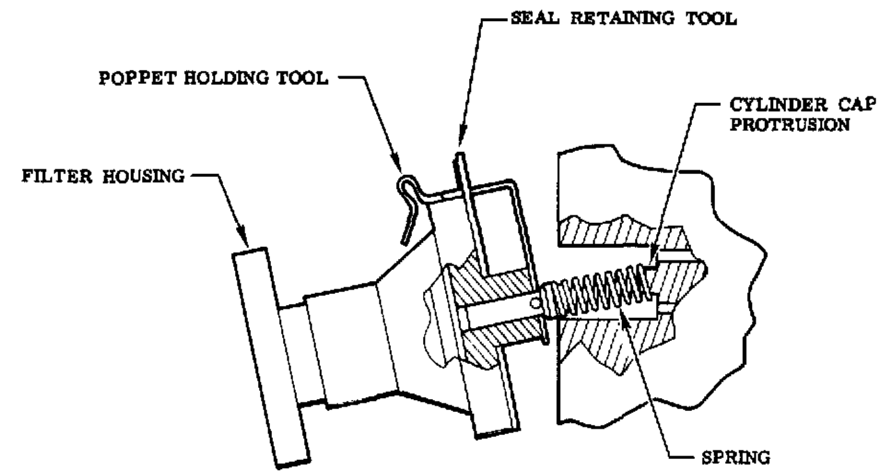


Figure 3-47-5. MOV Filter Housing Assembly Spring Installation

CAUTION

Spring must engage poppet and protrusion or valve timing will be affected.

d. Position filter housing (with seals, poppet, and spring) so that spring engages protrusion in cylinder cap. See figure 3-47-5. (Disregard seal retaining and poppet holding tools shown in illustration. They are not required in this procedure.)

e. Make sure drilled passage in cylinder cap and filter housing are alined and install bolts and washers that secure filter housing to cylinder cap. Torque (section I) bolts to 72-88 in-lb and lockwire them.

f. Position closing control line on filter housing and loosely install 2 bolts and washers. Position seal on line flange and install remaining bolts and washers. Torque bolts to 41-45 in-lb and lockwire them.

g. Reinstall removed electrical and line support clamps. See figure 3-47-1. Torque screws to 24-30 in-lb.

h. Refer to section IV for test requirements.

3-188A. <u>MAIN OXIDIZER VALVE POSITION INDICATOR</u>.

3-188B. REMOVING MAIN OXIDIZER VALVE POSITION INDICATOR. (See figure 3-47A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Before performing steps c and d, make sure MOV is in fully closed position.

c. Energize helium control valve, and pressurize engine helium tank with helium to 225-250 psig.

d. Depressurize system by decreasing pressure to helium tank to zero, allowing pressure to vent from helium tank, and deenergizing helium control valve.

e. Disconnect electrical connector (paragraph 3-30) P115 (1).

f. Remove screws (2) and lug (3), and separate housing (5) from mount (16). Use care to prevent damage to wiring.

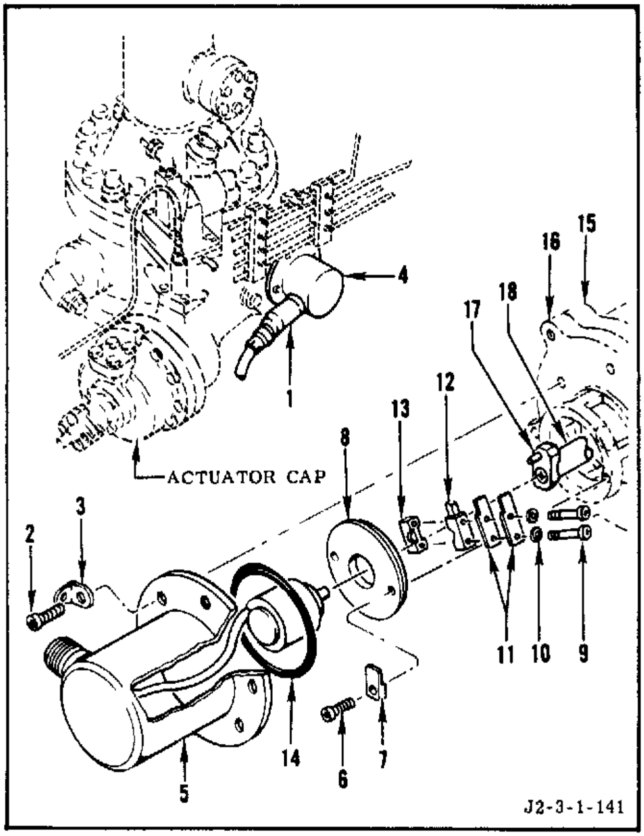
g. Remove screws (6) and clips (7).

h. Lift items index numbered 5 and 8 through 13 from end of shaft (18). Remove packing (14).

i. Remove screws (9), washers (10), springs (11), arm (12), and clamp (13) from shaft of indicator (4).

j. Protect and retain all items except packing (14) for reinstallation on MOV.

k. If indicator (4) is not immediately reinstalled, protect MOV and position indicator with clean protective material.



Index No.	Description
1	Electrical connector P115
2	Screw
3	Lug
4	Indicator
5	Housing
6	Screw
7	Clip
8	Base
9	Screw
10	Washer
11	Spring
12	Arm
13	Clamp
14	Packing
15	Housing
16	Mount
17	Arm
18	Shaft

Figure 3-47A. Main Oxidizer Valve Position Indicator

3-188C. INSTALLING MAIN OXIDIZER VALVE POSITION INDICATOR. (See figure 3-47A.)

a. If position indicator is being replaced, verify that position transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective material from MOV and from indicator (4). Make sure MOV and position indicator are clean and free of damage.

c. Remove protective material from all items that were retained for reinstallation. Make sure all items are clean and free of damage.

d. Install base (8) in place over potentiometer shaft of indicator (4).

e. Assemble 2 springs (11), arm (12), and clamp (13) with 2 washers (10) and 2 screws (9) and install on potentiometer shaft with bar of clamp (13) against flat on shaft and in position shown. Torque screws to 30-38 in-oz and safetywire.

f. Install packing (14) on mount (16) on housing (15).

g. Install base (8) on mount (16), and at same time match slot in arm assembly on potentiometer shaft with pin of arm (17) on shaft (18). Do not allow undue strain on wiring of indicator (4) while assembling components. Secure in position with clips (7) and screws (6). Tighten screws (6) fingertight.

h. Adjust indicator (4) as follows:

(1) Connect a Wheatstone bridge between pins A and B of J115.

(2) Connect a multimeter between pins D and E of connector J115.

(3) Rotate base (8) until Wheatstone bridge measures approximately 1,000 ohms.

(4) Slowly rotate base (8) in a clockwise direction until multimeter initially indicates 0.5 ohm or less.

(5) Balance Wheatstone bridge to determine resistance between pins A and B. Subtract 200 from determined resistance, and record result.

(6) Adjust Wheatstone bridge to measure result obtained in substep 5. Slowly rotate base (8) clockwise until bridge balances.

(7) Carefully tighten and torque screws (6) to 197-241 in-oz.

(8) Recheck resistance between pins A and B, and determine difference from result obtained in substep 5 (10 ohms maximum). Record value. Safetywire screws (6).

(9) Disconnect Wheatstone bridge and multimeter.

(10) Energize engine helium control and mainstage control valves.

(11) Pressurize engine helium tank with helium to 225-250 psig.

(12) Using a VTVM, measure resistance between the following pins of J115:

(a) A and B. Resistance must be 1,570 ±190 ohms, plus value obtained in substep 8.

(b) B and C. Resistance must be 475 ±150 ohms.

(c) E and F. Resistance must be 0.5 ohm maximum.

(13) Disconnect VTVM.

(14) Deenergize mainstage control valve.

(15) Decrease pressure to engine helium tank to zero.

(16) When all pressure has vented from helium tank, deenergize helium control valve.

i. Install housing (5) positioning electrical connector (1) and lug (3) on same axis with valve actuator cap. (Refer to figure 3-47A.) Install screws (2); torque screws to 27-32 in-lb and safetywire.

j. Connect electrical connector (paragraph 3-31) P115 (1).

k. Refer to section IV for test requirements.

3-189. MAINSTAGE OK PRESSURE SWITCH.

3-190. REMOVING MAINSTAGE OK PRESSURE SWITCH (ENGINES NOT INCORPORATING MD180 OR MD181 CHANGE). (See figure 3-48.)

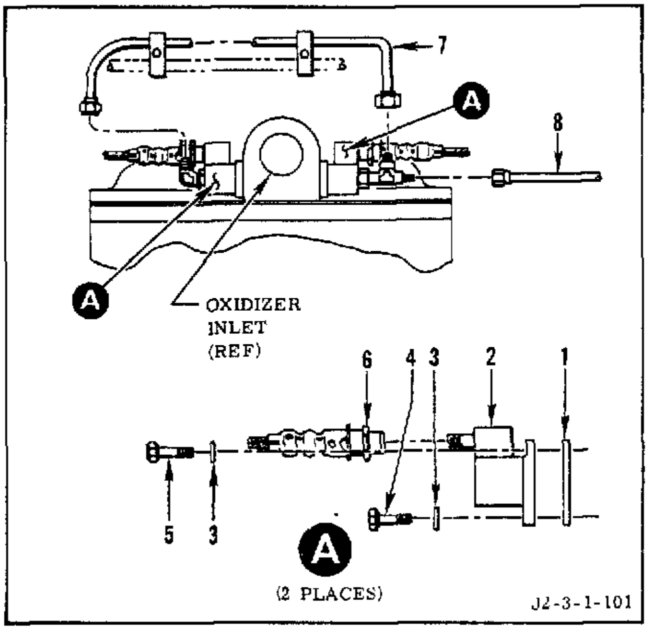
a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (6) (paragraph 3-30) P20 on switch No. 1, or P26 on switch No. 2.

c. Remove calips lines (7, 8) from tee on switch No. 1, or calips line (7) from elbow on switch No. 2.

d. Remove bolts (4, 5) and washers (3) that secure switch (2) to thrust chamber injector dome; then remove switch (2) and seal (1). Discard seal. Install clean protective closures (paragraph 3-258) on switch and injector dome.

e. If switch is to be replaced, remove and retain tee or elbow, and nut. Discard packing and O-ring. Install clean protective closures (paragraph 3-258) on open port and on tee or elbow.



Index Number	Description
1	Seal
2	Pressure switch
3	Washer
4	Bolt TS1101C4H28M
5	Bolt TS1101C4H16M
6	Electrical connector (P20 or P26)
7	Calips line
8	Calips line

Figure 3-48. Mainstage OK Pressure Switch (Engines Not Incorporating MD180 or MD181 Change)

3-191. REMOVING NO. 1 MAINSTAGE OK PRESSURE SWITCH (ENGINES INCORPORATING MD180 OR MD181 CHANGE). (See figure 3-49.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (8) (paragraph 3-30) P20.

c. Remove calips lines (9, 10) from tee. Install clean protective closures (paragraph 3-258) on tee and calips lines (9, 10).

d. Remove bolts (5, 6) and washers (4) that secure switch (2) to thrust chamber injector dome; then remove seal (1). Install clean protective closures (paragraph 3-258) on switch and injector dome.

e. If switch is to be replaced, remove and retain tee and nut. Discard packing and O-ring. Install clean protective closures (paragraph 3-258) on open port and tee.

3-192. REMOVING NO. 2 MAINSTAGE OK PRESSURE SWITCH (ENGINES INCORPORATING MD180 OR MD181 CHANGE). (See figure 3-49.)

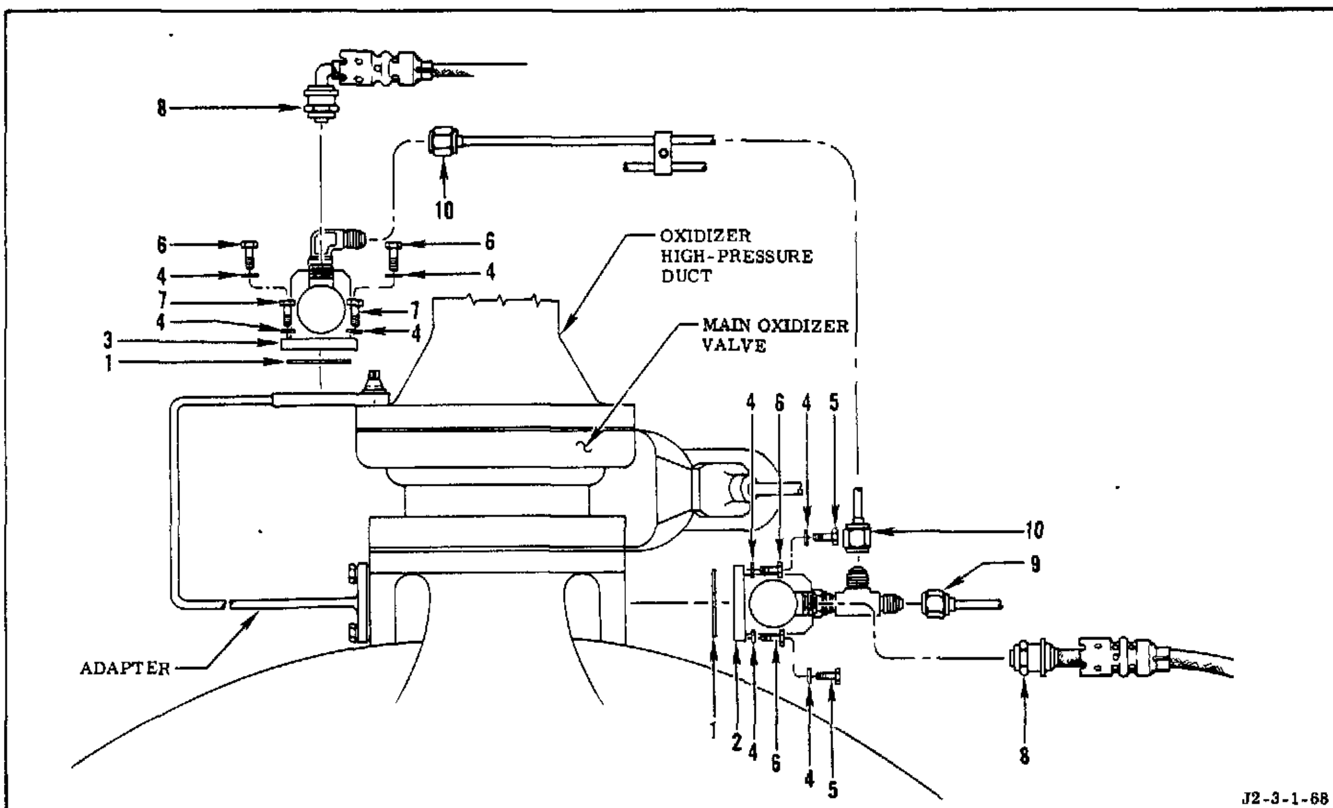
a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (8) (paragraph 3-30) P26.

c. Remove calip line (10) at elbow installed in pressure switch. Install clean protective closures (paragraph 3-258) on elbow and calip line (10).

d. Remove bolts (6, 7) and washers (4) that secure switch (3) to adapter; then remove seal (1). Install clean protective closures (paragraph 3-258) on switch and adapter.

e. If switch is to be replaced, remove and retain elbow and nut. Install clean protective closure (paragraph 3-258) on open port.



Index Number	Description	Index Number	Description
1	Seal	6	Bolt TS1101C4H28M
2	No. 1 pressure switch	7	Bolt TS1101C4H14M
3	No. 2 pressure switch	8	Electrical connector (P20 or P26)
4	Washer	9	Calips line
5	Bolt TS1101C4H16M	10	Calips line

Figure 3-49. Mainstage OK Pressure Switch (Engines Incorporating MD180 or MD181 Change)

3-193. INSTALLING MAINSTAGE OK PRESSURE SWITCH (ENGINES NOT INCORPORATING MD180 OR MD181 CHANGE). (See figure 3-48.)

a. If pressure switch is being replaced, verify that mainstage OK pressure switch preinstallation tests and stress corrosion inspection in R-3825-3, Volume II have been performed. If pressure switch is being reinstalled, perform stress corrosion inspection as outlined in R-3825-3, Volume II.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closure (paragraph 3-257) from thrust chamber injector dome.

c. Make sure injector dome, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

d. Remove protective closures (paragraph 3-257) from pressure switch.

e. Make sure switch and mating ports are clean, free of damage, and OK to install.

f. If pressure switch is being replaced, install tee or elbow, and nut (removed from old pressure switch) on new switch using O-ring and packing. Lubricate (Method J, section I) packing with lubricant grease RB0140-012 (Rocketdyne). Tighten nut fingertight.

g. Install pressure switch (2) on thrust chamber injector dome using bolts (4, 5), washers (3), and seal (1). Torque bolts (4) to 28-32 in-lb and bolts (5) to 15-17 in-lb and safetywire.

h. Rotate tee or elbow as required to provide proper alinement with calips lines, and torque nut to 75-100 in-lb.

i. Install calips lines (7, 8) on tee on switch No. 1, or calips line (7) on elbow on switch No. 2. Torque nuts to 135-180 in-lb.

j. Install electrical connector (6) (paragraph 3-31) P20 on switch No. 1, or P26 on switch No. 2.

k. Refer to section IV for test requirements.

3-194. INSTALLING NO. 1 MAINSTAGE OK PRESSURE SWITCH (ENGINES INCORPORATING MD180 OR MD181 CHANGE). (See figure 3-49.)

a. If pressure switch is being replaced, verify that mainstage OK pressure switch preinstallation tests and stress corrosion inspection in R-3825-3, Volume II have been performed. If pressure switch is being reinstalled, perform stress corrosion inspection as outlined in R-3825-3, Volume II.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closure from thrust chamber injector dome.

c. Make sure injector dome, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

d. Remove protective closures (paragraph 3-257) from pressure switch.

e. Make sure switch and mating ports are clean, free of damage, and OK to install.

f. If pressure switch is to be replaced, remove protective closures (paragraph 3-257) and install tee and nut (removed from old pressure switch) on new switch using O-ring and packing on tee. Lubricate (Method J, section I) packing with lubricant grease RB0140-012 (Rocketdyne). Tighten nut fingertight.

g. Install switch (2) on thrust chamber injector dome using bolts (5, 6), washers (4), and seal (1). Torque bolts (5) to 15-17 in-lb and bolts (6) to 28-32 in-lb and safetywire.

h. Rotate tee as required to provide proper alinement with calips line. Torque nut to 75-100 in-lb.

i. Remove protective closures (paragraph 3-257) and install calips lines (9, 10) on tee. Torque tube coupling nuts to 135-180 in-lb.

j. Install electrical connector (8) (paragraph 3-31) P20.

k. Refer to section IV for test requirements.

3-195. INSTALLING NO. 2 MAINSTAGE OK PRESSURE SWITCH (ENGINES INCORPORATING MD180 OR MD181 CHANGE). (See figure 3-49.)

a. If pressure switch is being replaced, verify that mainstage OK pressure switch preinstallation tests and stress corrosion inspection in R-3825-3, Volume II have been performed. If pressure switch is being reinstalled, perform stress corrosion inspection as outlined in R-3825-3, Volume II.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from pressure switch and adapter.

c. Make sure pressure switch, threads in parent metal, and/or threaded inserts of adapter are clean and free of damage, and threaded inserts are installed correctly (section I).

d. If pressure switch is to be replaced, remove protective closures (paragraph 3-257) and install elbow (removed from old pressure switch) on new switch. Install O-ring and packing on elbow. Lubricate (Method J, section I) packing with lubricant grease RB0140-012 (Rocketdyne). Torque to 75-100 in-lb.

e. Install switch (3) on adapter using bolts (6,7), washers (4), and seal (1). Torque bolts (6) to 28-32 in-lb and bolts (7) to 15-17 in-lb and safetywire.

f. Remove protective closure (paragraph 3-257), and install calips line (10) on switch (3) elbow. Torque to 135-185 in-lb.

g. Install electrical connector (8) (paragraph 3-31) P26.

h. Refer to section IV for test requirements.

3-195A. MIXTURE RATIO CONTROL VALVE.

3-195B. REMOVING MIXTURE RATIO CONTROL VALVE. (See figure 3-49A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. On engines incorporating MD318 change, if mixture ratio control valve is to be replaced, remove all insulation on valve, or remove only enough insulation for access to MRCV flange mounting bolts if same valve will be installed.

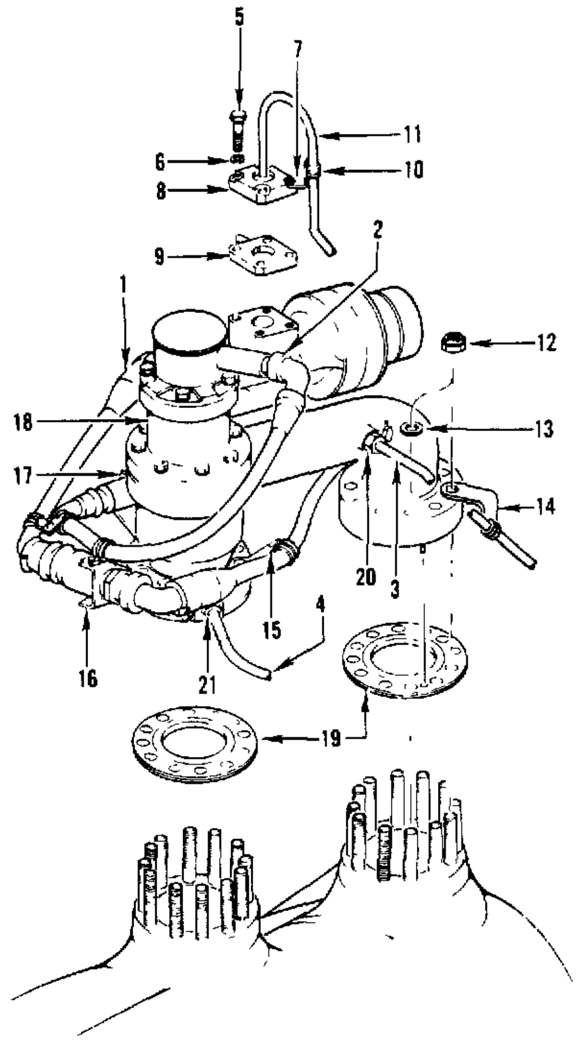
CAUTION

The mixture ratio control valve electrical harnesses have bayonet-type electrical connectors that can be damaged if the disconnection procedures in paragraph 3-30A are not followed.

c. Disconnect electrical connectors (paragraph 3-30A) P36A (1) and P119A (2).

d. Cut inlet pressure line P08 (3) and outlet pressure line P09 (4). (Refer to section VI for tube cutting requirements.) Protect open lines.

e. Remove bolts (5), washers (6), bracket (7), and flange (8) at control port of valve. Remove seal (9), and protect flange (8) and open port of valve. Retain bracket on clamp (10) attached to control line (11).



1 Electrical connector (P36A)
2 Electrical connector (P119A)
3 Inlet pressure line (P08)
4 Outlet pressure line (P09)
5 Bolt
6 Washer
7 Bracket
8 Control line flange
9 Seal
10 Clamp
11 Control line
12 Nut
13 Washer
14 Bracket
15 Bracket
16 Bracket
17 Bracket
18 Mixture ratio control valve
19 Seal
20 Inlet pressure adapter
21 Outlet pressure adapter

J2-3-1-154

Figure 3-49A. Mixture Ratio Control Valve

f. Remove nuts (12), washers (13), and brackets (14, 15, 16, 17) that secure valve (18) to turbopump. Remove valve (18) and seals (19) from turbopump. Cover openings in valve and turbopump. Retain brackets on control line (11) and harnesses.

g. Remove protective material and install protective closures (paragraph 3-258) one at a time on valve and engine openings.

3-195C. INSTALLING MIXTURE RATIO CONTROL VALVE. (See figure 3-49A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from engine. Make sure that openings for mixture ratio control valve are clean and free of damage, that threads of studs are free of damage and are correctly installed, and sealing surfaces of flanges are clean and free of damage. Protect openings and sealing surfaces.

c. If mixture ratio control valve is being replaced, install seals and adapters (20, 21) on replacement valve for inlet P08 and outlet P09 pressure lines. Torque adapters to 67-73 in-lb. Protect open ends of adapters.

d. Remove protective closures (paragraph 3-257) from mixture ratio control valve, and make sure valve, flanges, ports, connectors, and threads are clean and free of damage. Protect openings and sealing surfaces.

e. Remove protective material from valve flanges on oxidizer turbopump and install seals (19). Make sure seals are correctly positioned so that valve alinement pin will seat in hole in seal.

f. Remove protective material from mixture ratio control valve to oxidizer turbopump flanges and install valve (18) on oxidizer turbopump openings using washers (13), brackets (14, 15, 16, 17), and nuts (12). Torque nuts to 65-71 in-lb.

CAUTION

The mixture ratio control valve electrical harnesses have bayonet-type electrical connectors that can be damaged if the connection procedures in paragraph 3-31A are not followed.

g. Connect electrical connectors (paragraph 3-31A) P36A (1) and P119A (2).

h. Remove protective material from control line flange (8) and valve flange and install seal (9) with leak-test fitting on solenoid side of valve.

i. Attach control line flange (8) with washers (6), bracket (7), and bolts (5). Torque bolts to 68-82 in-lb.

j. If valve is being reinstalled, torque inlet pressure line (P08) adapter (20) and outlet pressure line (P09) adapter (21) to 67 in-lb. If each adapter tube stub alines with existing line, proceed to next step. If each adapter tube stub does not aline with existing line, remove and replace adapter and seal, and torque adapter to 67-73 in-lb.

k. Remove protective material from ends of inlet pressure line (3) and outlet pressure line (4) and weld lines. (Refer to section VI for welding requirements.)

l. Make sure control line flange seal leak-test fitting is covered with protective cap.

m. Refer to section IV for test requirements.

n. On engines incorporating MD318 change, repair or install new insulation on mixture ratio control valve housing using method outlined in R-3825-3, Volume II, paragraph titled Repairing Micro-Fibre Insulation. Insulation must cover housing from MRCV housing mounting flange to MRCV actuator mounting flange.

3-195D. MIXTURE RATIO CONTROL VALVE POSITION INDICATOR.

3-195E. REMOVING MIXTURE RATIO CONTROL VALVE POSITION INDICATOR. (See figure 3-49B.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

The mixture ratio control valve position indicator electrical harness has a bayonet-type electrical connector that can be damaged if the disconnection procedures in paragraph 3-30A are not followed.

b. Disconnect electrical connector (paragraph 3-30A) P119A (1).

c. Remove bolts (2), washers (3), position indicator (4), and seal (5) from MRCV (6).

d. Install protective material on open flange of MRCV (6).

e. Install protective material on open end of position indicator.

3-195F. INSTALLING MIXTURE RATIO CONTROL VALVE POSITION INDICATOR. (See figure 3-49B.)

a. If position indicator is being replaced, verify that position transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain the following:

(1) Voltmeter (accurate within 0.02 volt)

(2) Power supply capable of supplying 5.00 ±0.02 vdc

(3) Megger-tester having 50.00 ±5.00 vdc capability (used for insulation resistance testing)

(4) Potentiometer test cable XEOR938830 (used to connect equipment for applying and measuring voltage) (to be furnished by Rocketdyne Field Engineering)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective material from MRCV and position indicator. Make sure sealing surfaces of flanges are clean and free of damage.

CAUTION

Care must be taken to make sure the pin (located in the lever) is engaged in the slot of the position indicator. A disengaged pin could damage the position indicator.

d. Install seal (5), position indicator (4) (with connector J119 (7) oriented as shown in figure 3-49B and with pin in lever (8) engaged in slot of position indicator), washers (3), and bolts (2) on MRCV (6). Do not torque bolts, since bolts will be torqued after adjustment of position indicator.

e. On engines incorporating MD366 change, adjust position indicator as follows:

NOTE

On potentiometer test cable XEOR938830, the green plug corresponds to pin A (positive), the black plug corresponds to pin B, and the yellow plug corresponds to pin C.

(1) Make sure low EMR command is deenergized and MRCV is in closed (high EMR) position.

(2) Connect test equipment as shown in figure 3-49C.

(3) Apply 5.00 ±0.02 vdc to connector J119, pins A and C.

(4) Turn position indicator clockwise or counterclockwise to obtain 1.77 ±0.02 vdc measured at connector J119, pins B and C.

(5) Torque bolts (2, figure 3-49B) to 120-130 in-lb.

(6) Recheck voltage at connector J119, pins B and C. Voltage must be 1.77 ±0.02 vdc. Readjust position indicator if voltage is not within required limits.

(7) With engine helium tank pressurized to 250-1,600 psig at KSC or to 225-250 psig at all other sites, energize engine helium control valve and low EMR command to open MRCV (low EMR). (The engine mainstage control valve may be energized to prevent excessive loss of helium through engine purges.)

(8) With 5.00 ±0.02 vdc applied to connector J119, pins A and C, measure voltage at connector J119, pins B and C. Voltage must be 2.57 to ±0.15 vdc.

(9) Shut off pressure to engine helium tank. Deenergize mainstage control valve (if energized). When all pressure has vented from tank, deenergize helium control valve and low EMR command.

(10) With 5.00 ±0.02 vdc applied to connector J119, pins A and C, measure voltage at connector J119, pins B and C. Voltage must be 1.77 ±0.1 vdc.

(11) Turn off 5-vdc power supply, and disconnect test cable from power supply and voltmeter.

(12) Perform an insulation resistance test by applying 50.00 ±5.00 vdc for a minimum of one minute between connector J119, pins A, B, C (connected to a common lead), and engine ground strap. Resistance must be a minimum of 50 megohms.

(13) Disconnect test equipment from position indicator.

(14) Safetywire bolts torqued in substep 5.

f. On engines incorporating MD371 change, adjust position indicator as follows:

NOTE

On potentiometer test cable XEOR938830, the green plug corresponds to pin A (positive), the black plug corresponds to pin B, and the yellow plug corresponds to pin C.

(1) With engine helium tank pressurized to 250-1,600 psig at KSC or to 225-250 psig at all other sites, energize engine helium control valve and low EMR command to open MRCV (low EMR). (The engine mainstage control valve may be energized to prevent excessive loss of helium through engine purges.)

(2) Connect test equipment as shown in figure 3-49C.

(3) Apply 5.00 ±0.02 vdc to connector J119, pins A and C.

(4) Turn position indicator clockwise or counterclockwise to obtain 2.045 ±0.02 vdc measured at connector J119, pins B and C.

(5) Torque bolts (2, figure 3-49B) to 120-130 in-lb.

(6) Recheck voltage at connector J119, pins B and C. Voltage must be 2.045 ±0.02 vdc. Readjust position indicator if voltage is not within required limits.

(7) Deenergize low EMR command (MRCV will close).

(8) With 5.00 ±0.02 vdc applied to connector J119, pins A and C, measure voltage at connector J119, pins B and C. Voltage must be 0.50 ±0.25 vdc.

(9) Energize low EMR command (MRCV will open).

(10) With 5.00 ±0.02 vdc applied to connector J119, pins A and C, measure voltage at connector J119, pins B and C. Voltage must be 2.045 ±0.1 vdc.

(11) Shut off pressure to engine helium tank. Deenergize mainstage control valve (if energized). When all pressure has vented from tank, deenergize helium control valve and low EMR command.

(12) Turn off 5-vdc power supply, and disconnect test cable from power supply and voltmeter.

(13) Perform an insulation resistance test by applying 50.00 ±5.00 vdc for a minimum of one minute between connector J119, pins A, B, C (connected to a common lead), and engine ground strap. Resistance must be a minimum of 50 megohms.

(14) Disconnect test equipment from position indicator.

(15) Safetywire bolts torqued to substep 5.

CAUTION

The mixture ratio control valve position indicator electrical harness has a bayonet-type electrical connector that can be damaged if the connection procedures in paragraph 3-31A are not followed.

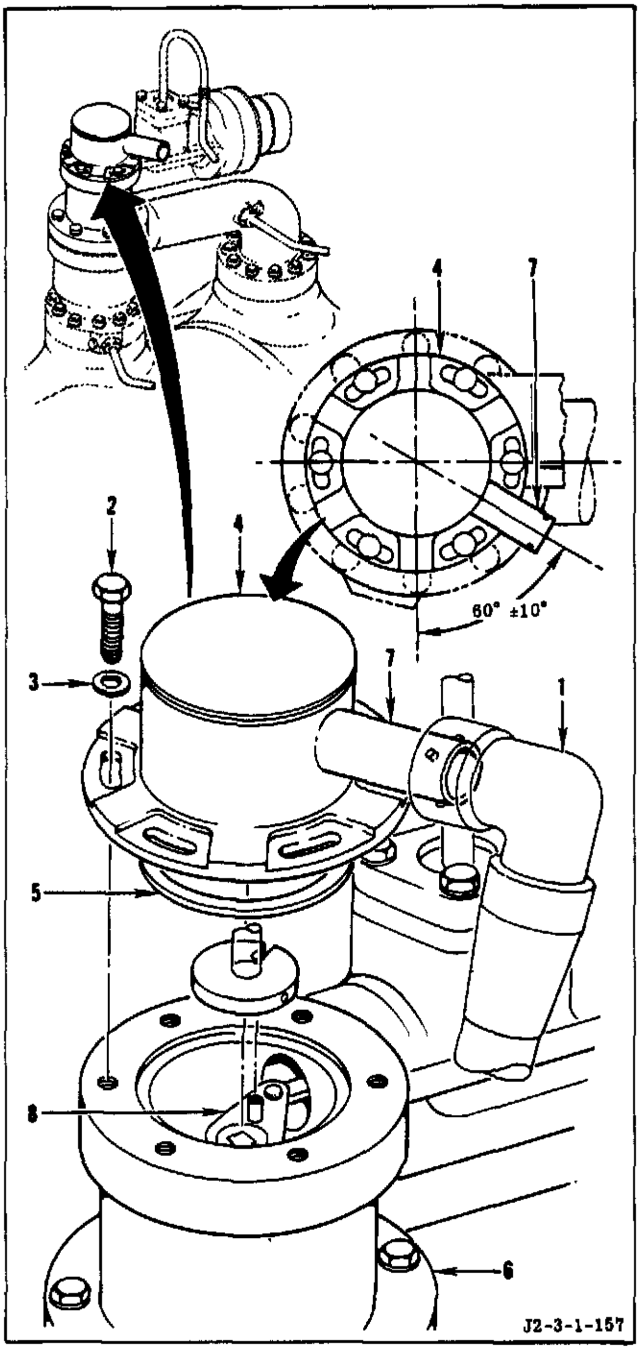
g. Connect electrical connector (paragraph 3-31A) P119A (1) to position indicator (4).

h. Refer to section IV for test requirements.

3-195G. MIXTURE RATIO CONTROL VALVE SOLENOID VALVE.

3-195H. REMOVING MIXTURE RATIO CONTROL VALVE SOLENOID VALVE. (See figure 3-49D.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.



Index No.	Description
1	Electrical connector P119A
2	Bolt
3	Washer
4	Position indicator
5	Seal
6	MRCV
7	Electrical connector J119
8	Lever

Figure 3-49B. Mixture Ratio Control Valve Position Indicator

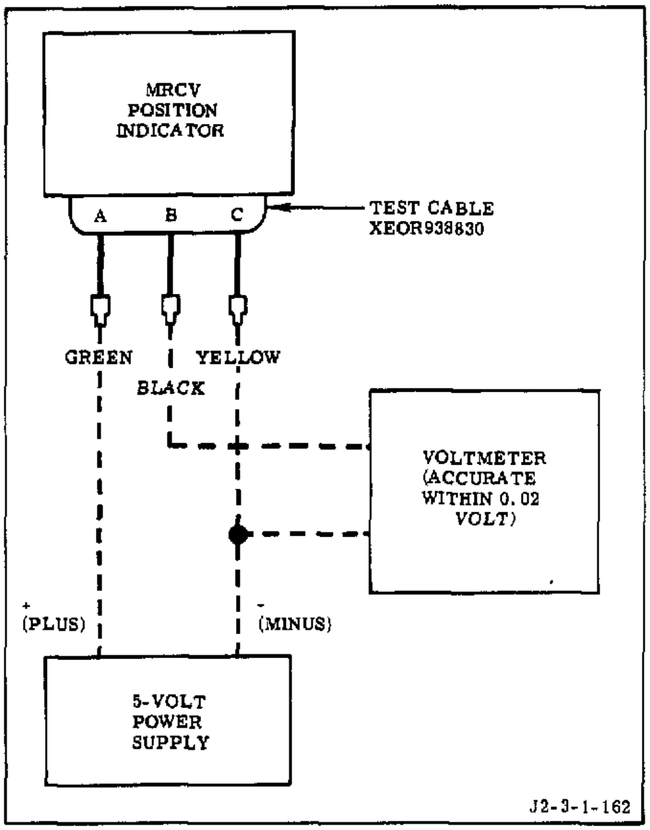


Figure 3-49C. Connecting Test Equipment to Mixture Ratio Control Valve Position Indicator

CAUTION

The mixture ratio control valve solenoid valve electrical harness has a bayonet-type electrical connector that can be damaged if the disconnection procedures in paragraph 3-30A are not followed.

b. Disconnect electrical connectors (paragraph 3-30A) P36A (1).

CAUTION

Care must be taken when separating the solenoid valve from the MRCV, since the seals may fall out when separation occurs and they may become damaged or lost.

c. Remove MRCV solenoid valve by removing bolt (2), washers (3), 2 seals (4), and one seal (5). Make sure not to drop seals when separating solenoid valve from MRCV.

d. Install clean protective closures (paragraph 3-258) on all open ports.

3-195J. INSTALLING MIXTURE RATIO CONTROL VALVE SOLENOID VALVE. (See figure 3-49D.)

a. If solenoid valve is being replaced, verify that solenoid valve preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain installation tool 557217.

b. Make sure tape on installation tool is not damaged and is free of any impressions indicating previous use. If tape is damaged or contains impressions, replace tape. Use P421 Teflon tape (Johnson and Johnson, Inc) or equivalent.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove closures (paragraph 3-257) from solenoid valve and mating ports on MRCV.

e. Make sure solenoid valve, mating surfaces, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

f. Make sure sealing surfaces, ports, and all components are clean, free of damage, and OK to install.

g. Install one seal (5), 2 seals (4), washers (3), and bolts (2) on solenoid valve.

h. Secure seals (4, 5) in position by positioning and taping installation tool 557217 on solenoid valve using pressure-sensitive tape (Federal Specification PPP-T-60), or equivalent. Do not apply tape to sealing surfaces.

i. Install solenoid valve and seals (4, 5) on MRCV with washers (3) and bolts (2). Torque bolts to 25 ±1 in-lb.

j. Remove tape that secures installation tool to valve.

k. Apply a slight pressure to solenoid valve and loosen bolts (2) approximately 1/4 turn. Continue to apply a slight pressure on solenoid valve and carefully remove installation tool; continue to apply pressure to valve, and retorque bolts to 25 ±1 in-lb.

l. Check impressions on Teflon tape on installation tool to make sure seals are correctly positioned. If tape on installation tool does not have a round impression at each of the 3 seal locations or if tape is cut or torn, remove solenoid valve and seals and reinstall as outlined in steps b and f through l.

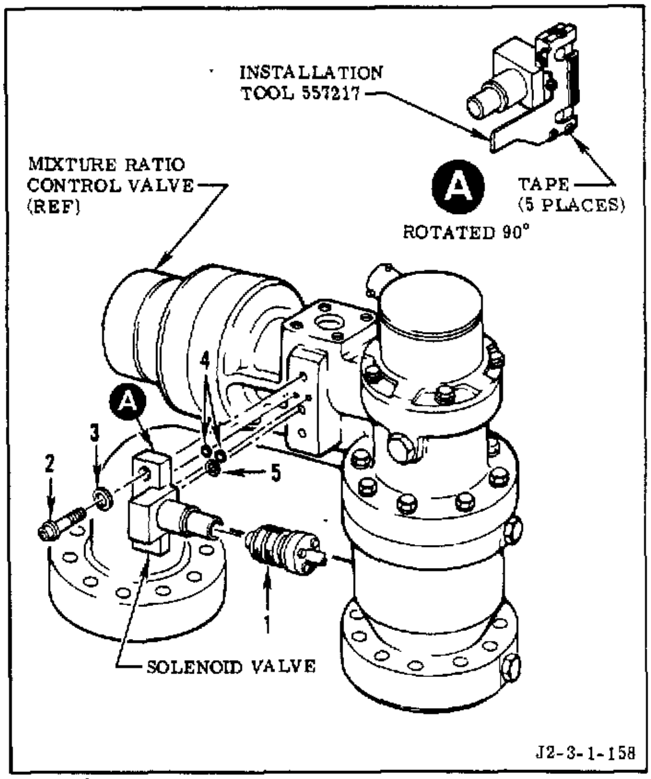
m. Torque bolts (2) to 160 ±8 in-lb.

CAUTION

The mixture ratio control valve solenoid valve electrical harness has a bayonet-type electrical connector that can be damaged if the connection procedures in paragraph 3-31A are not followed.

n. Connect electrical connector (paragraph 3-31A) P36A (1).

o. Refer to section IV for test requirements.



Index No.	Description
1	Electrical connector P36A
2	Bolt
3	Washer
4	Seal
5	Seal

Figure 3-49D. Mixture Ratio Control Valve Solenoid Valve

3-196. OXIDIZER AND FUEL FLOWMETERS AND FLOW STRAIGHTENERS.

3-197. REMOVING OXIDIZER AND FUEL FLOWMETERS AND FLOW STRAIGHTENERS. The oxidizer and fuel flowmeters may be reinstalled but not replaced without affecting engine calibration. (See figure 3-50.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove high-pressure ducts. Refer to paragraph 3-208 for removal procedures for oxidizer high-pressure duct and paragraph 3-51 for fuel high-pressure duct.

c. Remove nuts and washers that secure tie rods to ducts. Remove tie rods.

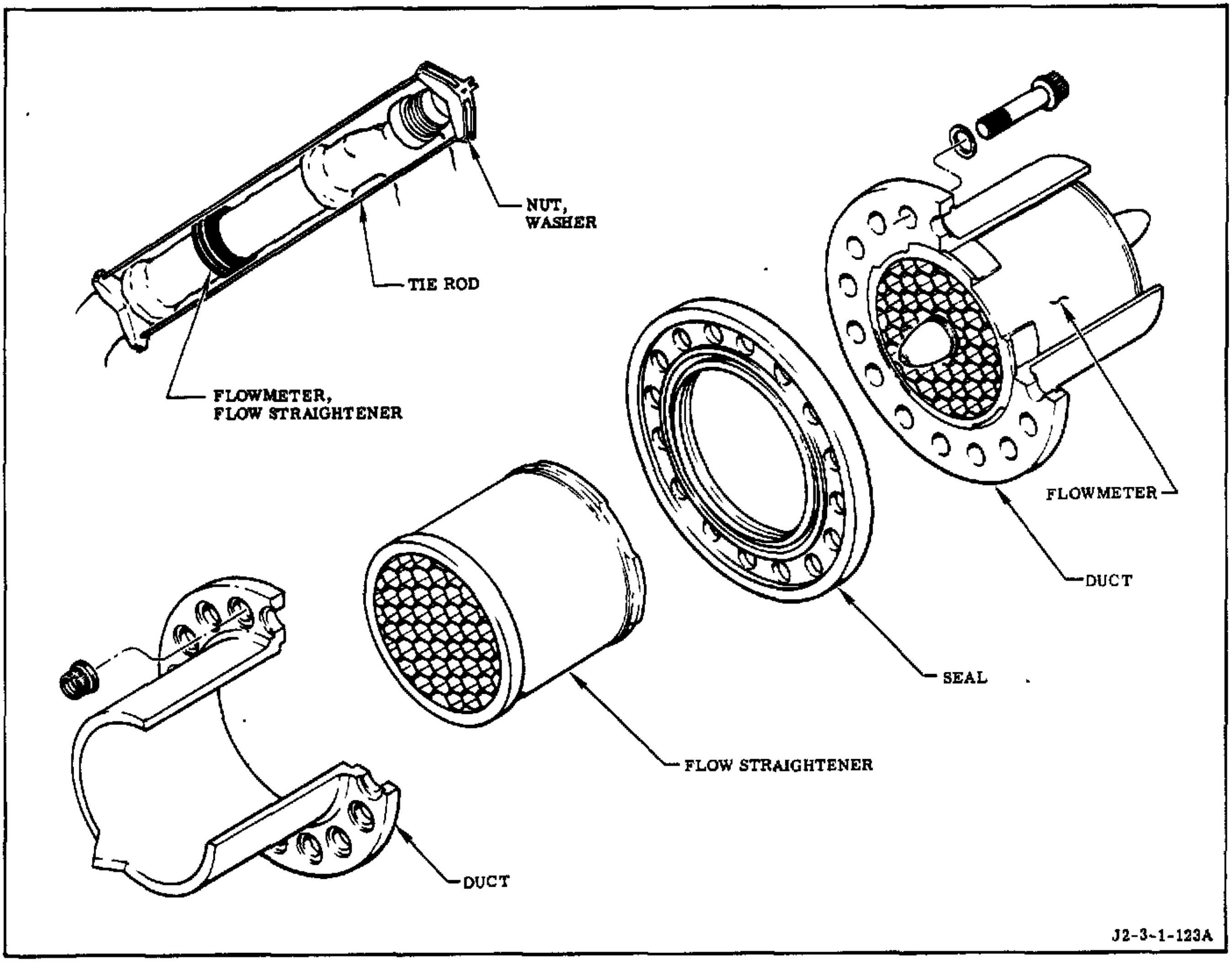


Figure 3-50. Oxidizer and Fuel Flowmeters and Flow Straighteners

d. On engines incorporating MD251 or MD252 change, remove strap from around insulation at center flange joint of oxidizer high-pressure duct.

e. Carefully cut and remove insulation from around flanged joint. Remove only enough insulation to permit removal of flange mating bolts.

f. Remove bolts, washers, and nuts that secure duct flanges. Separate duct and remove seal.

g. Remove flowmeter and flow straightener from ducts.

h. Install clean protective closures (paragraph 3-258) on all open ports.

3-198. INSTALLING OXIDIZER AND FUEL FLOWMETERS AND FLOW STRAIGHTENERS. The oxidizer and fuel flowmeters must be reinstalled. The oxidizer and fuel flow straighteners may be reinstalled or replaced. (See figure 3-50.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257); make sure ducts, flowmeter, and flow straightener are clean and free of damage; and install flowmeter and flow straightener in ducts, making sure that protrusion on ducts engage a recess on flow straightener and flowmeter.

c. Install seal and secure duct flanges with bolts, countersunk washers (section I), and nuts. Cross-torque bolts to 190-210 in-lb.

d. Install tie rods on ducts with washers and nuts fingertight.

e. On engines incorporating MD251 or MD252 change, install insulation on oxidizer high-pressure duct (paragraph 3-164).

f. Install high-pressure ducts. Refer to paragraph 3-208 for installing procedure for oxidizer high-pressure duct and paragraph 3-51 for fuel high-pressure duct.

g. Refer to section IV for test requirements.

3-198A. OXIDIZER AND FUEL FLOW TRANSDUCERS.

3-198B. REMOVING OXIDIZER AND FUEL FLOW TRANSDUCERS. (See figure 3-50A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector. (Refer to paragraph 3-30.)

c. Remove bolts, washers, lug or bracket (as applicable), and flow transducer.

d. Install clean protective closures (paragraph 3-258) on transducer, and on boss if a transducer is to be reinstalled in boss.

3-198C. INSTALLING OXIDIZER AND FUEL FLOW TRANSDUCERS. (See figure 3-50A.)

a. If transducer is being replaced, verify that flow transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from duct boss and mating connection of transducer. Make sure transducer, mating surfaces of boss, and threads in parent metal are clean and free of damage.

c. Insert transducer in boss, aline transducer connector key with electrical connector keyway as shown in figure 3-50A and secure with bolts, washers, and lug or bracket (as applicable). Torque bolts to 48-53 in-lb and safetywire.

d. Connect electrical connector (paragraph 3-31) to transducer.

e. Refer to section IV for test requirements.

3-199. OXIDIZER BLEED VALVE.

3-200. REMOVING OXIDIZER BLEED VALVE. The oxidizer bleed valve (figure 3-51) may be replaced without affecting engine calibration. The oxidizer bleed valve and GG oxidizer line, as an assembly (411619 or 411619-11), may be removed and reinstalled but not replaced without affecting engine calibration.

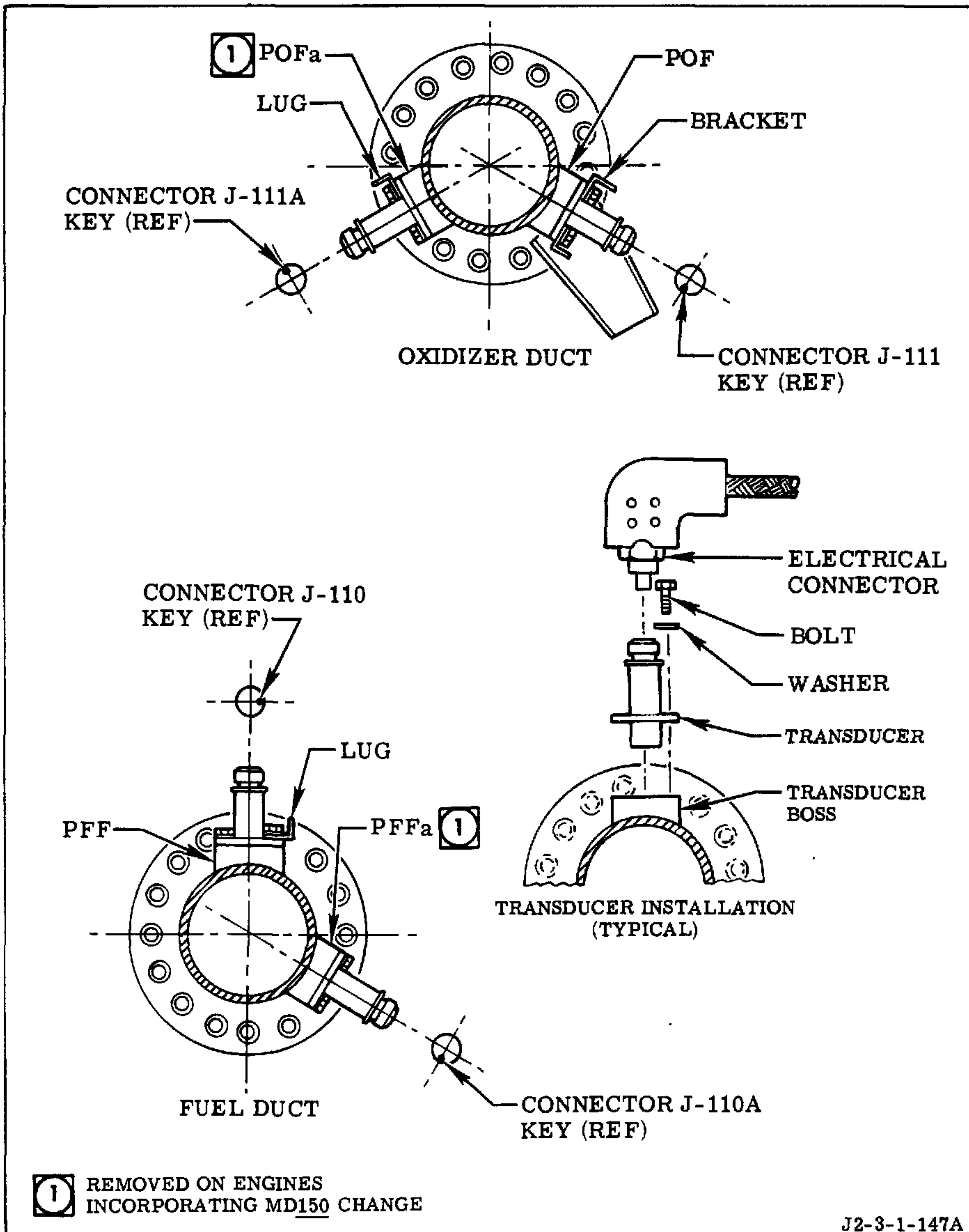


Figure 3-50A. Oxidizer and Fuel Flow Transducers

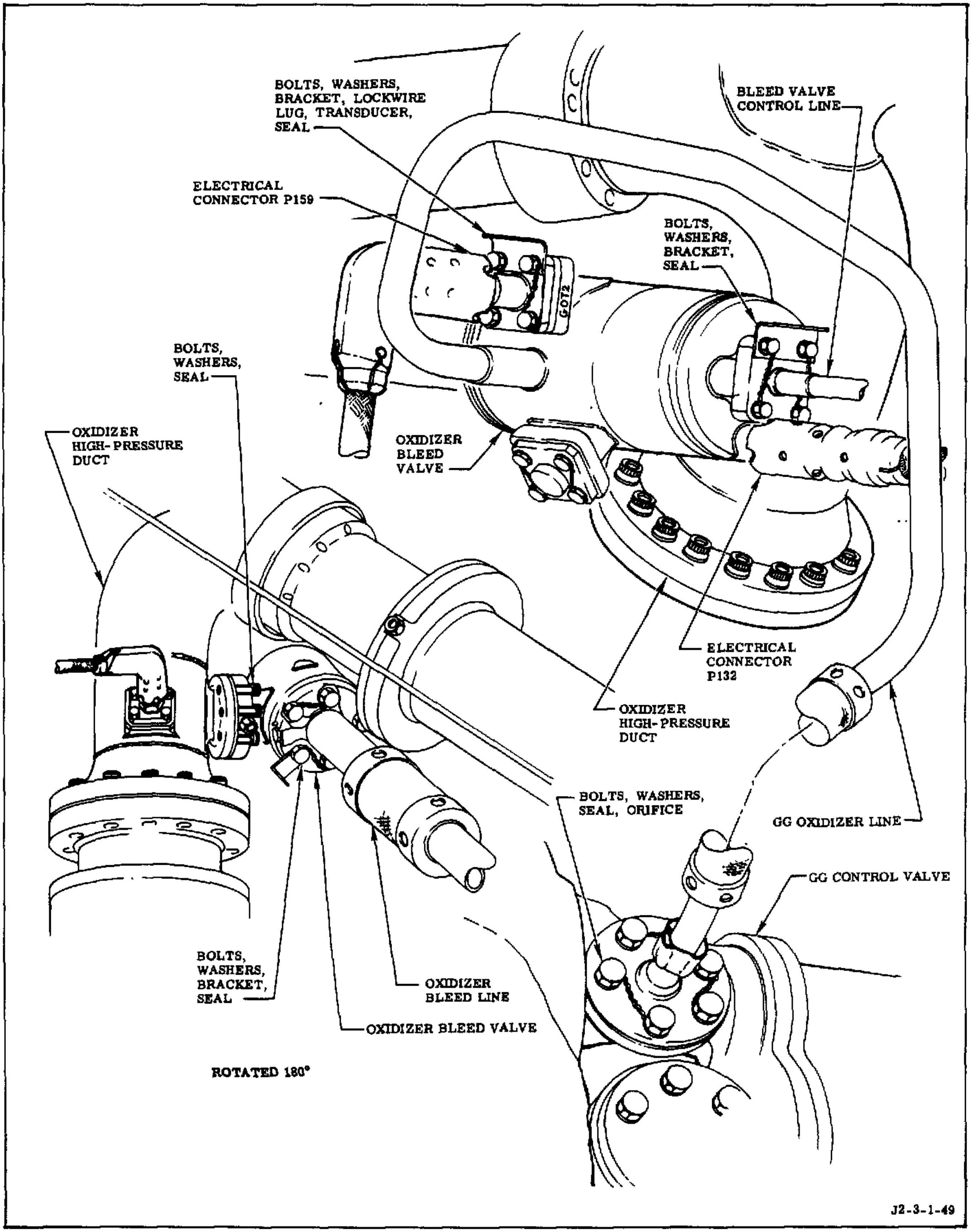


Figure 3-51. Oxidizer Bleed Valve

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connectors (paragraph 3-30) P132 and P159.

c. Remove bolts, washers, and bracket that secure oxidizer bleed line to oxidizer bleed valve; remove seal and protect open ports and sealing surfaces.

d. Remove bolts, washers, and bracket that secure oxidizer bleed valve control line to oxidizer bleed valve; remove seal and protect open ports and sealing surfaces.

e. Disconnect GG oxidizer line as follows:

(1) If oxidizer bleed valve and GG oxidizer line is being removed as an assembly, remove bolts and washers that secure GG oxidizer line to GG control valve; then remove seal and orifice. Retain orifice for reinstallation and protect open ports and sealing surfaces.

(2) If only the oxidizer bleed valve is being removed, cut GG oxidizer line between bleed valve and flex portion of line and protect open lines. (Refer to section VI for tube cutting requirements.)

f. Remove bolts and washers that secure oxidizer bleed valve to oxidizer high-pressure duct and remove valve and seal. Remove protective material from oxidizer bleed valve and engine ports; install clean protective closures (paragraph 3-258) on all open ports.

g. If oxidizer bleed valve is being replaced, remove and retain transducer, bracket, lockwire lug (GOT2 port), and seal vent port plugs from old bleed valve. Install clean protective closures (paragraph 3-258) on all open ports.

3-201. INSTALLING OXIDIZER BLEED VALVE. The oxidizer bleed valve (figure 3-51) may be replaced without affecting engine calibration. The oxidizer bleed valve and GG oxidizer line, as an assembly (411619 or 411619-11), may be reinstalled but not replaced without affecting engine calibration.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from oxidizer bleed valve and mating ports on engine. Make sure all ports and sealing surfaces, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. If oxidizer bleed valve is being replaced, proceed as follows:

(1) Remove protective material from port GO2, install plug (removed from replaced bleed valve) with seal, and torque to 67-74 in-lb.

(2) Remove protective material from plug in port GO2 and flange seal ports, and install bleed plugs (removed from replaced bleed valve) with seals. Tighten bleed plugs fingertight.

NOTE

Bleed plugs will be removed during leak test. Following leak test, bleed plugs will be reinstalled, torqued to 22-28 in-lb, and safetywired.

(3) Remove protective material from port GOT2 and transducer (removed from replaced bleed valve), install seal, and position transducer so keyway is alined with keyway in electrical connector P159. Install bracket, lockwire lug, bolts, and washers. Torque bolts to 47-53 in-lb and safetywire.

d. Position oxidizer bleed valve on engine, and remove protective material from mating ports on oxidizer high-pressure duct and oxidizer bleed valve. Install seal and secure bleed valve to high-pressure duct with bolts and washers. Torque bolts to 143-157 in-lb and safetywire.

e. Remove protective material from oxidizer bleed line flange and mating port on bleed valve. Install seal and bracket, and secure bracket, seal, and bleed line to bleed valve with bolts and washers. Torque bolts to 30-40 in-lb and safetywire.

f. Remove protective material from flange on bleed valve control line and mating flange on bleed valve. Install seal and bracket, and secure seal, bracket, and control line to bleed valve with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

g. Connect GG oxidizer line as follows:

CAUTION

Incorrect orifice installation will affect engine performance.

(1) If oxidizer bleed valve and GG oxidizer line are being installed as an assembly, remove protective material from GG oxidizer line flange and mating flange on oxidizer bleed valve. Install orifice (same orifice that was removed) on GG control valve (with flat side of orifice out). Install seal and secure GG oxidizer line to GG control valve with bolts and washers. Torque bolts to 48-52 in-lb and safetywire.

(2) If only the oxidizer bleed valve is being installed (GG oxidizer line is connected to GG control valve), weld GG oxidizer line. (Refer to section VI for weld requirements.)

h. Install electrical connectors (paragraph 3-31) P132 and P159.

i. Refer to section IV for test requirements.

3-202. <u>OXIDIZER BLEED LINE.</u>

3-203. REMOVING OXIDIZER BLEED LINE. (See figure 3-52.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove oxidizer bleed line flange bolts and washers at oxidizer bleed valve. Remove seal but leave small brackets attached to line and harness.

c. Remove screw, washer, nut, and clamp at standoff bracket.

d. Remove screw, washer, spacer, nut, and clamp at oxidizer turbopump support.

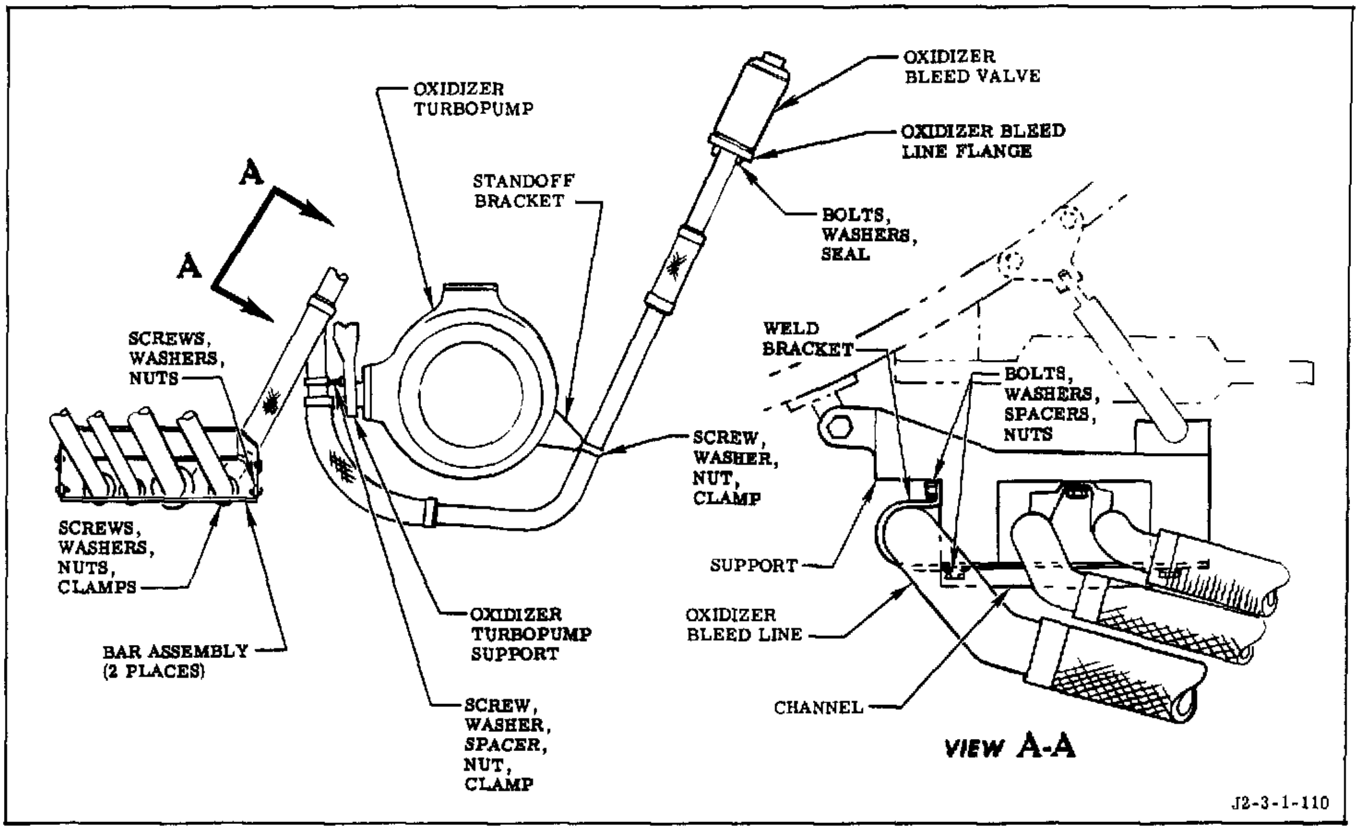


Figure 3-52. Oxidizer Bleed Line

e. Remove bolts, washers, spacers, nuts, and channel that secure weld bracket to support.

f. Remove screws, washers, clamps, and nuts that hold oxidizer bleed line, oxidizer tank pressurization line, fuel bleed line, and fuel tank pressurization line to front and rear bar assembly.

g. Remove screws, washers, nuts, and 2 bars.

h. Remove start tank support-and-fill valve (paragraph 3-290).

i. Remove oxidizer bleed line flange bolts from customer connect interface panel using Stage Contractor procedures. Protect open ports and sealing surfaces.

j. Remove oxidizer bleed line from engine. Install clean protective closures.

k. If oxidizer bleed line is to be replaced, remove leak-test plug and seal. Protect open ports and sealing surface.

3-204. *INSTALLING OXIDIZER BLEED LINE.* (See figure 3-52.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

WARNING

The following specifies white sealant RTV-102, which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

b. If oxidizer bleed line is replaced on engines incorporating MD318 change, insulate lower section of line in same place as on removed line, as follows:

(1) Install 2 layers of Micro-Fiber felt, Type E or Type 475 (Johns-Manville Products),

over oxidizer bleed line and secure with tying tape RB0150-026, Type III (Rocketdyne).

(2) Cover Micro-Fiber felt with 425 aluminum-foil tape (Minnesota Mining and Mfg).

(3) Seal wrinkled edges of aluminum-foil tape with white sealant RTV-102 (General Electric).

c. Remove protective closures (paragraph 3-257). Make sure oxidizer bleed line, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Remove protective material from oxidizer bleed line and oxidizer bleed valve mating flanges. Position oxidizer bleed line on engine, and install seal, bolts, washers, and brackets on oxidizer bleed valve and oxidizer bleed line flange. Torque bolts to 30-40 in-lb and safety-wire.

e. Remove protective material from oxidizer bleed line flange and customer connect interface panel. Install bolts, washers, and seal on oxidizer bleed line at customer connect interface panel using Stage Contractor procedures.

f. Install clamp, screw, washers, spacer, and nut on oxidizer bleed line at oxidizer turbopump support. Torque screw to 30-40 in-lb.

g. Install clamp, screw, washer, and nut at standoff bracket. Torque screw to 24-30 in-lb.

h. Install start tank support-and-fill valve. (Refer to paragraph 3-291.)

i. Install bolts, washers, spacers, nuts, channel, and weld bracket to support. Torque bolts to 55-75 in-lb and safetywire.

j. Install screws, washers, nuts, and the front and rear bar assembly. Do not torque nuts at this time.

k. Install clamps, screws, washers, and nuts on oxidizer bleed line, oxidizer tank pressurization line, fuel bleed line, and fuel tank pressurization line at front and rear bar assembly. Torque screws to 24-30 in-lb.

l. Torque nuts at each end of linkage bars until linkage locks and will not move; then back off nut 1/2 turn. Check for freedom of movement. Bar must not bind.

m. If oxidizer bleed line was replaced, install leak-test plug and seal. Torque plug to 22-28 in-lb.

n. Refer to section IV for test requirements.

3-205. OXIDIZER BLEED VALVE TEMPERATURE TRANSDUCER.

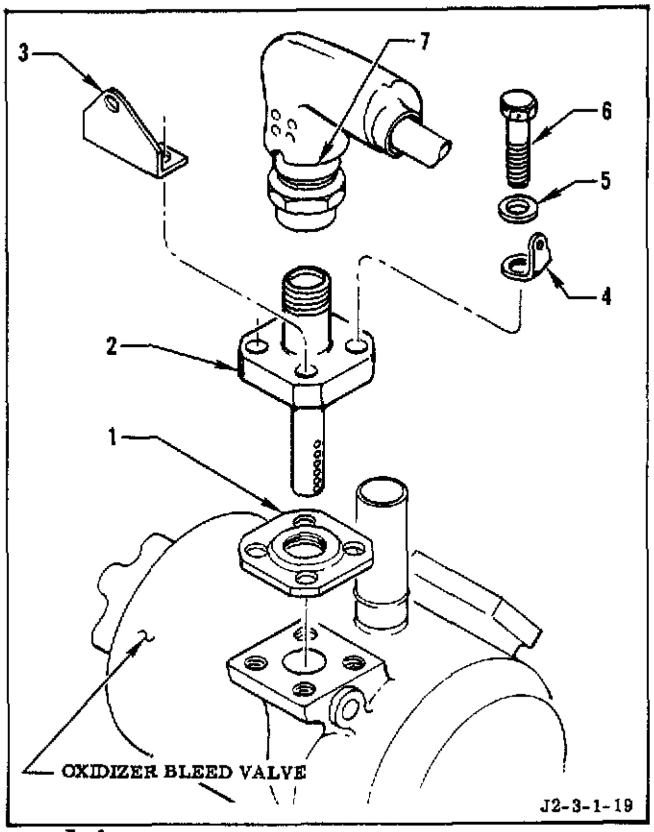
3-206. REMOVING OXIDIZER BLEED VALVE TEMPERATURE TRANSDUCER. (See figure 3-53.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Disconnect electrical connector (paragraph 3-30) P159 (7).

c. Remove bolts (6), washers (5), lug (4), bracket (3), transducer (2), and seal (1).

d. Install clean protective closure (paragraph 3-258) on open port of oxidizer bleed valve, and protect transducer.



Index No.	Description
1	Seal
2	Temperature transducer
3	Bracket
4	Lug
5	Washer
6	Bolts
7	Electrical connector P159

Figure 3-53. Oxidizer Bleed Valve Temperature Transducer

3-207. INSTALLING OXIDIZER BLEED VALVE TEMPERATURE TRANSDUCER. (See figure 3-53.)

a. If transducer is being replaced, verify that temperature transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closure (paragraph 3-257) from oxidizer bleed valve. Make sure bleed valve flange, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

c. Remove protective material from transducer.

d. Wipe transducer and boss sealing surfaces with a clean, lint-free cloth, and make sure sealing surfaces are free of nicks, scratches, deposits, or other imperfections that would impair sealing.

e. Place seal (1) over stem of transducer (2); insert and position transducer in boss to aline transducer connector key with electrical connector P159 keyway; then install bracket (3), lug (4), washers (5), and bolts (6).

f. Cross-torque bolts (6) to 48-53 in-lb and safetywire.

g. Connect electrical connector (paragraph 3-31) P159 (7) to transducer (2).

h. Refer to section IV for test requirements.

3-208. OXIDIZER HIGH-PRESSURE DUCT.

3-209. REMOVING OXIDIZER HIGH-PRESSURE DUCT (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-54.)

a. If engine is in engine handler, obtain the following:

(1) Oxidizer feed system handler 9016786

(2) Component handler universal lifting sling 9016779

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when the oxidizer high-pressure duct is removed from engines incorporating MD251 or MD252 change, to prevent damage to insulation.

c. Remove all clamps that secure lines and electrical harnesses to high-pressure duct. Note location and position of clamps for reinstallation.

d. Disconnect electrical connectors (paragraph 3-30) P111 and P125.

e. Remove bolts and washers that secure oxidizer bleed valve to oxidizer high-pressure duct; remove seal and protect open ports and sealing surfaces.

f. Cut oxidizer turbopump discharge pressure instrumentation line PO3. (Refer to section VI for tube cutting requirements.)

g. On engines not incorporating MD105 change, remove bolts and washers that secure heat exchanger inlet line to oxidizer high-pressure duct; remove seal and protect open ports and sealing surfaces.

h. On engines incorporating MD180 or MD181 change, remove No. 2 mainstage OK pressure switch (paragraph 3-192).

i. On engines incorporating MD180 or MD181 change, remove bolts and washers that secure pressure switch adapter; remove pressure switch adapter and seal, and protect open ports and sealing surfaces.

j. Remove bolts and washers that secure purge control valve bracket to flange at MOV. Support weight of purge control valve.

k. Support weight of oxidizer high-pressure duct using oxidizer feed system handler, universal lifting sling, and overhead hoist. If engine is in unstacked stage, use suitable means to support weight of duct (64 pounds).

l. Remove bolts and washers that secure oxidizer high-pressure duct to turbopump, and remove bracket and spacers.

m. Remove remaining bolts and washers that secure oxidizer high-pressure duct to MOV; remove seals at each end of high-pressure duct, and protect open ports and sealing surfaces.

n. Remove oxidizer high-pressure duct.

o. Remove the following parts from oxidizer duct if duct is being replaced, and protect open ports and sealing surfaces:

(1) Cover, seals, washers, and bolts near outlet flange

(2) Plugs and gaskets at leak-test ports

(3) Oxidizer turbopump discharge temperature tranducer (POT3) (paragraph 3-134)

(4) Oxidizer flowmeter pickup (paragraph 3-198B)

p. Remove protective material, and install clean protective closures (paragraph 3-258).

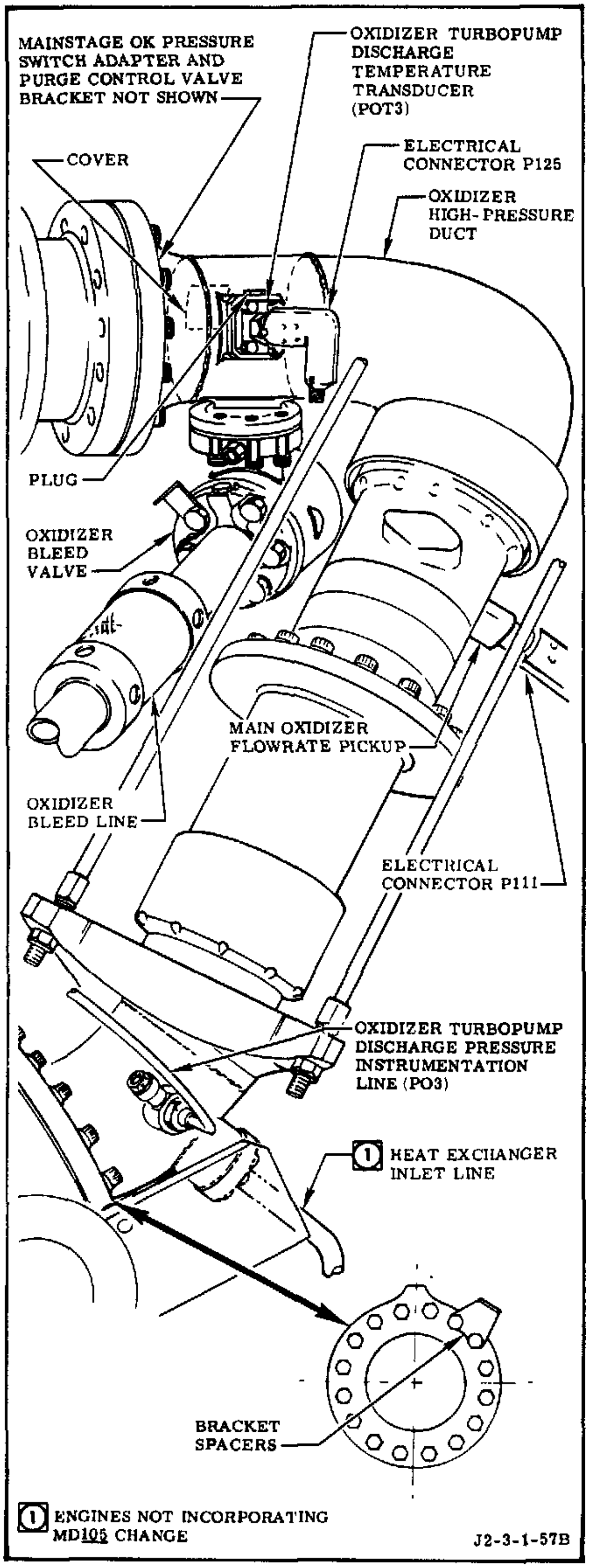


Figure 3-54. Oxidizer High-Pressure Duct

3-210. REMOVING OXIDIZER HIGH-PRESSURE DUCT (STACKED SII STAGE). (See figure 3-54.)

a. Obtain the following: (Items 2 through 5 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Oxidizer feed system handler 9016786

(2) Component handler universal lifting sling 9016779

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Component handling cart 9026253-11 from engine components installer set 9026251

(7) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. Install track (section V) around engine position from which duct is to be removed. Install turntable with controls leading, and position hoist at track station 12 for engine positions 1 through 4, or track station 20 for engine position 5.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when the oxidizer high-pressure duct is removed from engines incorporating MD251 or MD252 change, to prevent damage to insulation.

d. Remove all clamps that secure lines and electrical harnesses to high-pressure duct. Note location and position of clamps for reinstallation.

e. Disconnect electrical connectors (paragraph 3-30) P111 and P125.

f. Remove bolts and washers that secure oxidizer bleed valve to oxidizer high-pressure duct; remove seal, and protect open ports and sealing surfaces.

fA. Cut oxidizer turbopump discharge pressure instrumentation line PO3. (Refer to section VI for tube cutting requirements.)

g. On engines not incorporating MD105 change, remove bolts and washers that secure heat exchanger inlet line to oxidizer high-pressure duct; remove seal, and protect open ports and sealing surfaces.

h. On engines incorporating MD180 or MD181 change, remove No. 2 mainstage OK pressure switch (paragraph 3-192).

i. On engines incorporating MD180 or MD181 change, remove bolts and washers that secure pressure switch adapter; remove pressure switch adapter and seal, and protect open ports and sealing surfaces.

j. Remove bolts and washers that secure purge control valve bracket to flange at MOV. Support weight of purge control valve.

k. Install handler on oxidizer high-pressure duct with straps attached to black hooks, elbow upward, and hoist socket approximately horizontal and pointing toward center of engine.

l. Connect hoist to handler and secure with ball-lock pin.

m. Manipulate hoist to support weight of oxidizer high-pressure duct.

n. Remove bolts and washers that secure oxidizer high-pressure duct to turbopump and remove bracket.

o. Remove remaining bolts and washers that secure oxidizer high-pressure duct to MOV; remove seals at each end of high-pressure duct, and protect open ports and sealing surfaces.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps p through s.

p. Using hoist, move duct to an accessible area near stage access door and place duct on protective pad.

q. Install component handler universal lifting sling on handler and secure with ball-lock pin.

r. Install chain hoist on hoist.

s. Connect chain-hoist hook to component handler universal lifting sling and raise oxidizer high-pressure duct with chain hoist.

t. Transport oxidizer high-pressure duct through stage access door and lower duct into component handling cart. Disengage component from hoist, manually lifting component (64 pounds) if necessary to disengage.

u. Remove the following parts from oxidizer duct if duct is being replaced, and protect open ports and sealing surfaces:

(1) Cover, seal, washers, and bolts near outlet flange

(2) Plugs and gaskets at leak-test ports

(3) Oxidizer turbopump discharge temperature transducer (POT3) (paragraph 3-134)

(4) Oxidizer flowmeter pickup (paragraph 3-198B).

v. Remove protective material, and install clean protective closures (paragraph 3-258).

3-211. REMOVING OXIDIZER HIGH-PRESSURE DUCT (STACKED SIVB STAGE). (See figure 3-54.)

a. Obtain oxidizer feed system handler 9016786.

b. Assemble track for oxidizer high-pressure duct removal (refer to section V). Install turntable with controls trailing.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when the oxidizer high-pressure duct is removed from engines incorporating MD251 change, to prevent damage to insulation.

d. Remove all clamps that secure electrical harnesses and lines to high-pressure duct. Note location and position of clamps for reinstallation.

d. Disconnect electrical connectors (paragraph 3-30) P111 and P125.

f. Remove bolts and washers that secure oxidizer bleed valve to oxidizer high-pressure duct; remove seal, and protect open ports and sealing surfaces.

fA. Cut oxidizer turbopump discharge pressure instrumentation line PO3. (Refer to section VI for tube cutting requirements.)

g. On engines not incorporating MD105 change, remove bolts and washers that secure heat exchanger inlet line to oxidizer high-pressure duct; remove seal, and protect open ports and sealing surfaces.

h. On engines incorporating MD180 or MD181 change, remove No. 2 mainstage OK pressure switch (paragraph 3-192).

i. On engines incorporating MD180 or MD181 change, remove bolts and washers that secure pressure switch adapter; remove pressure switch adapter and seal, and protect open ports and sealing surfaces.

j. Remove bolts and washers that secure purge control valve bracket to flange at MOV. Support weight of purge control valve.

k. Install handler on oxidizer high-pressure duct with straps attached to black hooks, elbow upward, and hoist socket approximately horizontal and pointing toward center of engine.

l. Connect hoist to handler and secure with ball-lock pin.

m. Manipulate hoist to support weight of oxidizer high-pressure duct (64 pounds).

n. Remove bolts and washers that secure oxidizer high-pressure duct to turbopump, and remove bracket.

o. Remove remaining bolts and washers that secure oxidizer high-pressure duct to MOV; remove seals at each end of high-pressure duct, and protect open ports and sealing surfaces.

p. Using hoist, move oxidizer high-pressure duct to an accessible area near stage access door.

q. Remove duct from handler and manually carry oxidizer high-pressure duct (64 pounds) from stage.

r. Remove the following parts from oxidizer duct if duct is being replaced, and protect open ports and sealing surfaces:

(1) Cover, seal, washers, and bolts near outlet flange

(2) Plugs and gaskets at leak-test ports

(3) Oxidizer turbopump discharge temperature transducer (POT3) (paragraph 3-134)

(4) Oxidizer flowmeter pickup (paragraph 3-198B)

s. Remove protective material, and install clean protective closures (paragraph 3-258).

3-212. INSTALLING OXIDIZER HIGH-PRESSURE DUCT (ENGINE HANDLER OR UNSTACKED STAGE). (See figure 3-54.)

a. If duct is to be installed on engine in engine handler obtain the following:

(1) Oxidizer feed system handler 9016786

(2) Component handler universal lifting sling 9016779

aA. Perform the following steps if oxidizer duct and flowmeter was replaced:

(1) Remove protective closure (paragraph 3-257) and install cover, seal, washers, and bolts near outlet flange. Torque bolts to 30-40 in-lb.

(2) Remove protective closures (paragraph 3-257) and install gaskets and plugs at leak-test ports. Install plugs fingertight.

NOTE

Plugs will be removed during leak test. After leak test, plugs will be reinstalled, torqued to 22-28 in-lb, and safetywired.

(3) Remove protective closure and install oxidizer turbopump discharge temperature transducer (POT3) (paragraph 3-135).

(4) Install oxidizer flowmeter pickup (paragraph 3-198C).

CAUTION

Care must be taken when the oxidizer high-pressure duct is installed on engines incorporating MD251 or MD252 change, to prevent damage to insulation.

b. If oxidizer high-pressure duct is to be installed on an engine in engine handler, install oxidizer feed system handler on oxidizer duct. Attach universal lifting sling to oxidizer feed system handler.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove protective closures (paragraph 3-257). *Make sure oxidizer high-pressure duct*, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

e. If oxidizer high-pressure duct is to be installed on engine in handler, attach overhead hoist to universal lifting sling, and using overhead hoist, position duct on engine. If duct is to be installed on engine in unstacked stage, provide suitable means of handling weight of oxidizer high-pressure duct (64 pounds).

f. Remove protective material from mating flanges to MOV-to-oxidizer duct, install seal, position purge control valve bracket on oxidizer duct flange, and install bolts and washers that secure purge control valve bracket. Tighten bolts fingertight.

g. On engines incorporating MD180 or MD181 change, remove protective material from flanges of pressure switch adapter and its mating surface on oxidizer dome, install seal, position pressure switch adapter on duct and dome, and install bolts and washers that secure pressure switch adapter to duct and dome. Tighten bolts that secure adapter to duct fingertight. Cross-torque bolts that secure adapter to dome to 55-65 in-lb and safetywire.

h. Install remaining bolts and washers that secure duct to MOV. Tighten bolts fingertight.

i. Remove protective material from mating flanges of oxidizer turbopump to oxidizer high-pressure duct, install seal, position bracket and spacers on flange, and install bolts and washers that secure duct to turbopump. Tighten bolts fingertight.

NOTE

For ease of installation, the tie rods may be used to compress the ducts a maximum of 0.75 inch.

j. Remove handler from discharge duct.

k. Back off tie-rod nuts to remove all preloading.

l. Cross-torque bolts that secure oxidizer duct to MOV to 570-630 in-lb and safetywire.

m. Cross-torque bolts that secure oxidizer duct to oxidizer turbopump to 361-399 in-lb and safetywire.

n. Tighten tie-rod nuts until a 0.025-inch feeler gage fits snugly between tie-rod nut and washer at one end of each of the 3 tie rods.

o. While holding tie-rod nut on one end of tie rod, tighten nut on other end exactly 3 complete revolutions. Repeat this operation on other 2 tie rods, and safetywire nuts to tie rods.

p. On engines not incorporating MD105 change, remove protective material from mating flanges of heat exchanger inlet line to oxidizer high-pressure duct, install seal, and install bolts and washers that secure line to duct. Cross-torque bolts to 48-54 in-lb and safetywire.

q. Remove protective material from mating flanges of oxidizer bleed valve to oxidizer duct, install seal, and install bolts and washers that secure bleed valve to duct. Cross-torque bolts to 143-157 in-lb and safetywire.

r. Connect electrical connectors (paragraph 3-31) P111 and P125.

s. On engines incorporating MD180 or MD181 change, install No. 2 mainstage OK pressure switch (paragraph 3-195).

t. Check torque of oxidizer turbopump discharge pressure instrumentation line PO3 adapter. Torque must be 67-73 in-lb. If torque is less than 67 in-lb, remove adapter, replace seal, reinstall adapter, and torque to 67-73 in-lb.

u. Remove protective material, and weld oxidizer turbopump discharge pressure instrumentation line PO3. (Refer to section VI for tube welding requirements.)

v. Install clamps (section I) that secure lines and electrical harnesses to high-pressure duct.

w. Refer to section IV for test requirements.

3-213. INSTALLING OXIDIZER HIGH-PRESSURE DUCT (STACKED SII STAGE). (See figure 3-54.)

a. Obtain the following: (Items 2 through 5 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Oxidizer feed system handler 9016786

(2) Component handler universal lifting sling 9016779

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Component handling cart 9026253-11 from engine components installer set 9026251

(7) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

aA. Perform the following steps if oxidizer duct and flowmeter was replaced:

(1) Remove protective closure (paragraph 3-257) and install cover, seal, washers, and bolts near outlet flange. Torque bolts to 30-40 in-lb.

(2) Remove protective closures (paragraph 3-257) and install gaskets and plugs at leak-test ports. Install plugs fingertight.

NOTE

Plugs will be removed during leak test. After leak test, plugs will be reinstalled, torqued to 22-28 in-lb, and safetywired.

(3) Remove protective closure and install oxidizer turbopump discharge temperature transducer (POT3) (paragraph 3-135).

(4) Install oxidizer flowmeter pickup (paragraph 3-198C).

CAUTION

Care must be taken when the oxidizer high-pressure duct is installed on engines incorporating MD251 or MD252 change, to prevent damage to insulation.

b. Install feed system handler on oxidizer high-pressure duct with straps attached to black hooks and oriented in such a manner so that when handler is suspended from hoist socket, high-pressure duct will be in approximate installed attitude.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps d through h.

d. Install chain-hoist boom, and extend hoist boom through stage access door.

e. Install sling on handler and secure with ball-lock pin.

f. Lower hoist hook and attach to lifting ring of sling.

g. Using hoist, raise duct, transfer duct in through stage access door, and place duct on protective pad.

h. Remove hoist from hoist boom and sling from handler.

i. Connect handler to hoist and secure with ball-lock pin. Position hoist at track station 12 for engine positions 1 through 4, or track station 20 for engine position 5.

j. Remove protective closures (paragraph 3-257). Make sure oxidizer high-pressure duct, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

k. Using hoist, move oxidizer high-pressure duct into position on engine.

l. Remove protective material from mating flanges of MOV-to-oxidizer duct, install seal, position purge control valve bracket on oxidizer duct flange, and install bolts and washers that secure purge control valve bracket. Tighten bolts fingertight.

m. On engines incorporating MD180 or MD181 change, remove protective material from flange of pressure switch adapter and its mating surface on oxidizer dome, install seal, position pressure switch adapter on duct and dome, and install bolts and washers that secure pressure switch adapter to duct and dome. Tighten bolts that secure adapter to duct fingertight. Cross-torque bolts that secure adapter to dome to 55-65 in-lb and safetywire.

n. Install remaining bolts and washers that secure duct to MOV. Tighten bolts fingertight.

o. Remove protective material from mating flanges of oxidizer turbopump to oxidizer high-pressure duct, install seal, position bracket and spacers on flange, and install bolts and washers that secure duct to turbopump. Tighten bolts fingertight.

NOTE

For ease of installation, the tie rods may be used to compress the duct a maximum of 0.75 inch.

p. Remove handler from discharge duct.

q. Back off tie-rod nuts to remove all preloading.

r. Cross-torque bolts that secure oxidizer duct to MOV to 570-630 in-lb and safetywire.

s. Cross-torque bolts that secure oxidizer duct to oxidizer turbopump to 361-399 in-lb and safetywire.

t. Disassemble track (section V).

u. Tighten tie-rod nuts until a 0.025-inch feeler gage fits snugly between tie-rod nut and washer at one end of each of the 3 tie rods.

v. While holding tie-rod nut on one end of tie rod, tighten nut on other end exactly 3 complete revolutions. Repeat this operation on other 2 tie rods, and safetywire nuts to tie rods.

w. On engines not incorporating MD105 change, remove protective material from mating flanges of heat exchanger inlet line to oxidizer high-pressure duct, install seal, and install bolts and washers that secure line to duct. Cross-torque bolts to 48-54 in-lb and safetywire.

x. Remove protective material from mating flanges of oxidizer bleed valve to oxidizer duct, install seal, and install bolts and washers that secure bleed valve to duct. Cross-torque bolts to 143-157 in-lb and safetywire.

y. Connect electrical connectors (paragraph 3-31) P111 and P125.

z. On engines incorporating MD180 or MD181 change, install No. 2 mainstage OK pressure switch (paragraph 3-195).

aa. Check torque of oxidizer turbopump discharge pressure instrumentation line PO3 adapter. Torque must be 67-73 in-lb. If torque is less than 67 in-lb, remove adapter, replace seal, reinstall adapter, and torque to 67-73 in-lb.

ab. Remove protective material, and weld oxidizer turbopump discharge pressure instrumentation line PO3. (Refer to section VI for tube welding requirements.)

ac. Install clamps (section I) that secure lines and electrical harnesses to high-pressure duct.

ad. Refer to section IV for test requirements.

3-214. INSTALLING OXIDIZER HIGH-PRESSURE DUCT (STACKED SIVB STAGE). (See figure 3-54.)

a. Obtain oxidizer feed system handler 9016786.

aA. Perform the following steps, if oxidizer duct and flowmeter was replaced:

(1) Remove protective closure (paragraph 3-257) and install cover, seal, washers, and bolts near outlet flange. Torque bolts to 30-40 in-lb.

(2) Remove protective closures (paragraph 3-257) and install gaskets and plugs at leak-test ports. Install plugs fingertight.

NOTE

Plugs will be removed during leak test. After leak test, plugs will be reinstalled, torqued to 22-28 in-lb, and safetywired.

(3) Remove protective closure and install oxidizer turbopump discharge temperature transducer (POT3) (paragraph 3-135).

(4) Install oxidizer flowmeter pickup (paragraph 3-198C).

b. Manually carry oxidizer high-pressure duct (64 pounds) into stage and lay duct on a protective pad.

c. Install feed system handler on oxidizer high-pressure duct with straps attached to black hooks, and oriented in such a manner so that when handler is suspended from hoist socket, high-pressure duct will be in approximate installed attitude.

d. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

e. Connect handler to hoist and secure with ball-lock pin. Using hoist, move oxidizer high-pressure duct near installation area on engine.

f. Remove protective closures (paragraph 3-257). Make sure oxidizer high-pressure duct, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

g. Using hoist, move oxidizer high-pressure duct into position on engine.

h. Remove protective material from mating flanges of MOV-to-oxidizer duct, install seal, position purge control valve bracket on oxidizer duct flange, and install bolts and washers that secure purge control valve bracket. Tighten bolts fingertight.

i. On engines incorporating MD180 or MD181 change, remove protective material from flange of pressure switch adapter and its mating surface on oxidizer dome, install seal, position pressure switch adapter on duct and dome, and install bolts and washers that secure pressure switch adapter to duct and dome. Tighten bolts that secure adapter to duct fingertight. Cross-torque bolts that secure adapter to dome to 55-65 in-lb and safetywire.

j. Install remaining bolts and washers that secure duct to MOV. Tighten bolts fingertight.

k. Remove protective material from mating flanges of oxidizer turbopump to oxidizer high-pressure duct, install seal, position bracket and spacers on flange, and install bolts and washers that secure duct to turbopump. Tighten bolts fingertight.

NOTE

For ease of installation, the tie rods may be used to compress the duct a maximum of 0.75 inch.

l. Remove handler from discharge duct.

m. Back off tie-rod nuts to remove all preloading.

n. Cross-torque bolts that secure oxidizer duct to MOV to 570-630 in-lb and safetywire.

o. Cross-torque bolts that secure oxidizer duct to oxidizer turbopump to 361-399 in-lb and safetywire.

p. Disassemble track (section V).

q. Tighten tie-rod nuts until a 0.025-inch feeler gage fits snugly between tie-rod nut and washer at one end of each of the 3 tie rods.

r. While holding tie-rod nut on one end of tie rod, tighten nut on other end exactly 3 complete revolutions. Repeat this operation on other 2 tie rods, and safetywire nuts to tie rods.

s. On engines not incorporating MD105 change, remove protective material from mating flanges of heat exchanger inlet line to oxidizer high-pressure duct, install seal, and install bolts and washers that secure line to duct. Cross-torque bolts to 48-54 in-lb and safetywire.

t. Remove protective material from mating flanges of oxidizer bleed valve to oxidizer duct, install seal, and install bolts and washers that secure bleed valve to duct. Cross-torque bolts to 143-157 in-lb and safetywire.

u. Connect electrical connectors (paragraph 3-31) P111 and P125.

v. On engines incorporating MD180 or MD181 change, install No. 2 mainstage OK pressure switch (paragraph 3-195).

w. Check torque of oxidizer turbopump discharge pressure instrumentation line PO3 adapter. Torque must be 67-73 in-lb. If torque is less than 67 in-lb, remove adapter, replace seal, reinstall adapter, and torque to 67-73 in-lb.

x. Remove protective material, and weld oxidizer turbopump discharge pressure instrumentation line PO3. (Refer to section VI for tube welding requirements.)

y. Install clamps (section I) that secure lines and electrical harnesses to high-pressure duct.

z. Refer to section IV for test requirements.

3-215. OXIDIZER INJECTOR PURGE CHECK VALVE.

3-216. REMOVING OXIDIZER INJECTOR PURGE CHECK VALVE. (See figure 3-55.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Cut injector purge line. (Refer to section VI for tube cutting requirements.) Protect open ends of line.

bA. Remove plug and bleeder (8), gasket (7), plug (6), and seal (5). Retain plugs for reinstallation. Protect open port.

c. Remove bolts (4), washers (3), valve (2), and seal (1). Protect open ports.

NOTE

The injector purge check valve housing may be loose when the check valve is removed from the MOV. This condition is acceptable and does not constitute a reason for rejecting the valve.

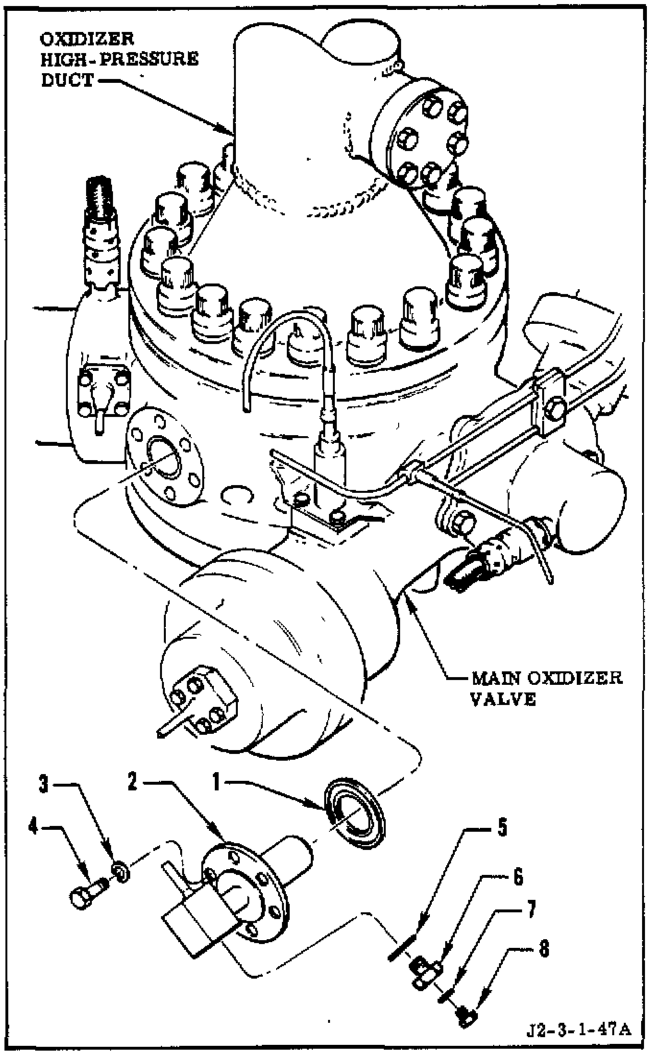
3-217. INSTALLING OXIDIZER INJECTOR PURGE CHECK VALVE. (See figure 3-55.)

a. If check valve is being replaced, verify that purge and seal drain check valve preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. (Deleted)

c. Remove protective closure (paragraph 3-257) from MOV. Make sure MOV mating surface, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open port.



Index No.	Description
1	Seal
2	Valve
3	Washer
4	Bolt
5	Seal
6	Plug
7	Gasket
8	Plug and Bleeder

Figure 3-55. Oxidizer Injector Purge Check Valve

d. Remove protective closure (paragraph 3-257) from check valve. Make sure check valve is clean and free of damage, and torque check valve housing to 25-50 in-lb. Installation of check valve with a loose housing will result in leakage between the MOV and check valve.

e. Install seal (1), valve (2), washers (3), and bolts (4). Torque bolts (4) to 41-45 in-lb and safetywire.

eA. Remove protective material and install seal (5), plug (6), gasket (7), and plug and bleeder (8). Torque plug (6) to 66-73 in-lb and safetywire. Torque plug and bleeder (8) to 22-28 in-lb and safetywire.

NOTE

A reverse leakage test and flange seal leak check of the oxidizer injector purge check valve may be made at this time. Refer to section IV.

eB. Disconnect electrical connectors (paragraph 3-30) P120 and P125 as necessary, for access to weld purge line.

f. Remove protective material and weld injector purge line. (Refer to section VI for tube welding requirements.) Connect electrical connectors (paragraph 3-31) P120 and P125 (as applicable).

g. Refer to section IV for test requirements.

3-218. OXIDIZER INLET DUCT.

3-219. REMOVING OXIDIZER INLET DUCT (ENGINE HANDLER). The oxidizer inlet duct (figure 3-56) may be replaced without affecting engine calibration.

a. Obtain the following equipment:

(1) Inlet duct sling 9024400.

(2) Torque wrench adapter T-5040045.

(3) Oxidizer pump inlet flange adapter RX-19142-11.

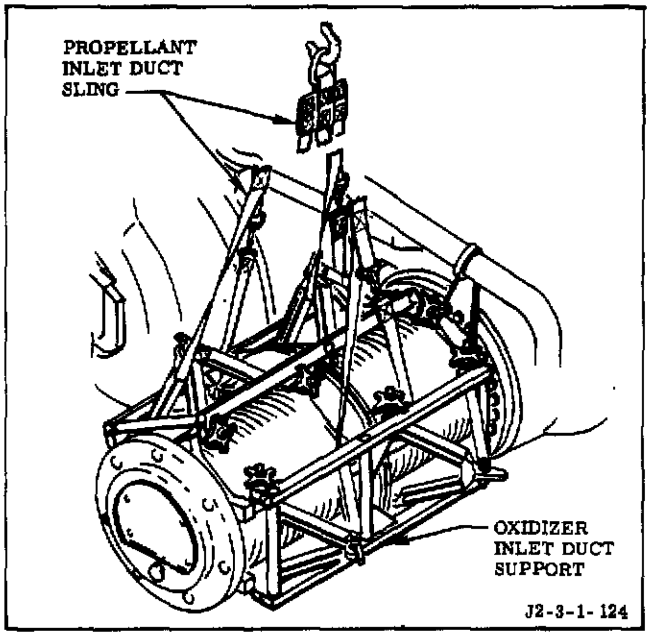


Figure 3-56. Oxidizer Inlet Duct

(4) Pump inlet closure RX-20714.

(5) Plate RX-20823-41.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when the oxidizer inlet duct is removed from engines incorporating MD251 change, to prevent damage to insulation.

NOTE

Insulation can be reinstalled if not damaged during removal. Cutting insulation within 1/2 inch of the bond, but not on the bond joint, will prevent damage.

c. If insulation is installed on duct, carefully remove insulation (paragraph 3-155) as necessary.

d. Make sure torsional ring protective covers are installed on inlet duct.

CAUTION

The use of the incorrect inlet duct supports can damage the engine.

- Oxidizer inlet duct supports must be in place when using inlet duct sling 9024400, to prevent damage to the oxidizer inlet duct.

e. Attach inlet duct sling 9024400 to oxidizer inlet duct by looping 3 straps through inlet duct bipods and connecting snap fasteners.

f. Attach lifting eye of inlet duct sling 9024400 to a hoist, and raise hoist until sling supports weight of inlet duct (94 pounds).

CAUTION

The use of excessive lifting force of the hoist on the installed inlet duct can damage the engine.

g. Remove bolts and washers that secure inlet duct to turbopump inlet flange, using torque wrench adapter only when necessary.

h. Record location of, and support, turbopump accelerometer and mount, and oxidizer bleed line and bracket as necessary.

i. Raise and move inlet duct clear of turbopump inlet flange taking care not to bump or otherwise damage sealing surfaces.

j. Remove seal from turbopump inlet flange.

k. Make sure turbopump inlet and flange are clean and free of damage.

l. Install oxidizer pump inlet flange adapter on turbopump inlet using 8 bolts and washers. Torque bolts to 25-30 in-lb.

m. Install pump inlet closure (paragraph 3-258) on adapter using 8 screws.

n. Install plate (paragraph 3-258) on inlet duct flange.

o. Make sure inlet duct covers and inlet duct pads are installed.

3-220. REMOVING OXIDIZER INLET DUCT (UNSTACKED STAGE). The oxidizer inlet duct (figure 3-56) may be replaced without affecting engine calibration. This procedure covers removal of the duct from engines installed in the SIVB stage and from positions 1 through 4 on the SII stage. Removal of the duct from an engine installed in position 5 in the SII stage must be done in accordance with applicable Stage Contractor procedures.

a. Obtain the following equipment:

(1) Torque wrench adapter T-5040045.

(2) Inlet duct support frame installing tool kit 9025150.

(3) Test plate 9022696-11.

(4) Teflon sheet EWR 915729.

(5) Oxidizer duct plate EWR 972056.

(6) Aclar No. 33C film (Allied Chemical Corp).

(7) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(8) Plate RX-20823-41.

(9) Oxidizer pump inlet flange adapter RX-19142-11.

(10) Pump inlet closure RX-20714.

(11) Plate RK395-52111-003.

(12) Inlet ducts closure RK395-10124, or -011.

(13) Oxidizer inlet duct supports RK395-44100-101 and/or -021.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when oxidizer inlet duct is removed from engines incorporating MD251 change, to prevent damage to insulation.

NOTE

Insulation can be reinstalled if not damaged during removal. Cutting insulation within 1/2 inch of the bond, but not on the bond joint, will prevent damage.

c. If insulation is installed on duct, carefully remove insulation (paragraph 3-155) as necessary.

d. Make sure torsional ring protective covers are installed on inlet duct.

e. Remove bolts and washers that secure inlet duct to turbopump inlet flange, using torque wrench adapter only when necessary.

f. Record location and support the turbopump accelerometer and mount, and oxidizer bleed line and bracket as necessary.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

g. Install 3 turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150 on inlet duct bipods.

h. Compress duct by tightening the 3 turnbuckles evenly, in small increments, until duct has been compressed enough to remove seal from turbopump inlet flange. Do not compress duct to less than 18.85 inches.

i. Remove seal from turbopump inlet flange.

j. Make sure turbopump inlet and flange are clean and free of damage.

k. Install test plate 9022696-11 on turbopump inlet flange using four bolts. Seal threaded port in center of test plate using pressure-sensitive tape RB0195-002 (Rocketdyne).

l. Place Teflon sheet on test plate.

m. Install oxidizer duct plate EWR 972056 on lower flange of inlet duct with bolts.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

n. Loosen 3 turnbuckles evenly, in small increments, so that plate on inlet duct flange contacts Teflon sheet on turbopump inlet flange.

nA. Using an appropriate block and tackle or pulley arrangement, support inlet duct to appropriate stage structure to prevent dropping duct and to assist lowering of duct.

o. Using Stage Contractor procedures, remove bolts and washers that secure inlet duct to customer connect flange.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

p. Support inlet duct and compress duct by tightening the 3 turnbuckles evenly, in small increments, until seal at customer connect flanges can be removed. Do not compress to less than 18.85 inches.

q. Remove seal from customer connect flange.

r. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange and customer connect flange. Fasten in place with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

s. Remove inlet duct by slowly sliding duct on Teflon sheet until duct clears turbopump and customer connect flanges, taking care not to bump or otherwise damage sealing surfaces.

t. Remove Teflon sheet and test plate from turbopump inlet flange.

u. Make sure turbopump inlet and flange are clean and free of damage.

v. Install oxidizer pump inlet flange adapter on turbopump inlet using 8 bolts and washers. Torque bolts to 25-30 in-lb.

w. Install pump inlet closure (paragraph 3-258) on adapter using 8 screws.

x. Remove oxidizer duct plate EWR 972056 from lower flange of inlet duct.

y. Make sure inlet duct and flange are clean and free of damage.

z. Install plate RK395-52111-003 (paragraph 3-258) on lower flange of inlet duct.

aa. Remove Aclar film and tape from customer connect flange and install protective closure as specified in Stage Contractor procedures.

ab. Remove Aclar film and tape from upper flange of fuel inlet duct and install plate and inlet ducts closure (paragraph 3-258) using 12 screws and washers.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The use of the incorrect inlet duct supports can damage the engine.

ac. Using turnbuckles to adjust length of fuel inlet duct, install fuel inlet duct supports (minimum of 2) on inlet duct with hand knobs to right side of bipods when duct is viewed from inlet end.

ad. Remove turnbuckles from inlet duct bipods.

ae. Make sure inlet duct covers and inlet duct pads are installed.

3-221. REMOVING OXIDIZER INLET DUCT (STACKED SII STAGE). The oxidizer inlet duct (figure 3-56) may be replaced without affecting engine calibration. This procedure covers removal of the duct from engines installed in positions 1 through 4. Removal of the duct from an engine installed in position 5 must be done in accordance with applicable Stage Contractor procedures. The procedure in paragraph 3-220, Removing Oxidizer Inlet Duct (Unstacked Stage), may be used if additional provisions are made to protect personnel from injury and equipment from damage in a stacked stage.

a. Install track and hoist (section V) run-in around engine position (1 through 4) from which inlet duct is to be removed. Install turntable with controls following, and position hoist at track station 20 for engine positions 1 through 4.

b. Obtain the following equipment: (Items 3 through 5 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Angle adapter 9027172 from Engine Components Installer G4071, shelf 2.

(2) Oxidizer inlet duct handler 9016785-11.

(3) Chain-hoist 9027095 from engine components installer set 9026251.

(4) Universal joint S8 from engine components installer set 9026251.

(5) Extension bar SX-24 from engine components installer set 9026251.

(6) Components handling cart 9026253-11 from engine components installer set 9026251.

(7) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm).

(8) Torque wrench adapter T-5040045.

(9) Inlet duct support frame installing tool kit 9025150.

(10) Test plate 9022696-11.

(11) Teflon sheet EWR 915729.

(12) Oxidizer duct plate EWR 972056.

(13) Aclar No. 33C film (Allied Chemical Corp).

(14) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(15) Plate RX-20823-41.

(16) Oxidizer pump inlet flange adapter RX-19142-11.

(17) Pump inlet closure RX-20714.

(18) Plate RK395-52111-003.

(19) Inlet ducts closure RK395-10124 or -011.

(20) Oxidizer inlet duct supports RK395-44100-101 and/or -021.

c. Install angle adapter on hoist, in position shown in figure 3-6, view E.

d. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when the oxidizer inlet duct is removed from engines incorporating MD251 change, to prevent damage to insulation.

NOTE

Insulation can be reinstalled if not damaged during removal. Cutting insulation within 1/2 inch of the bond joint, but not on the bond joint, will prevent damage.

e. If insulation is installed on duct, carefully remove insulation (paragraph 3-155).

eA. Make sure torsional ring protective covers are installed on inlet duct.

f. Remove bolts and washers that secure inlet duct to turbopump inlet flange, using torque wrench adapter only when necessary.

g. Record location of, and support, turbopump accelerometer and mount, and oxidizer bleed line and bracket as necessary.

h. Install handler on oxidizer inlet duct with adapter positioned toward track station 20.

hA. Compress duct to maximum allowed by handler.

i. Remove seal from turbopump inlet flange.

j. Make sure turbopump inlet and flange are clean and free of damage.

k. Install test plate 9022696-11 on turbopump inlet flange using bolts.

l. Place Teflon sheet on test plate.

m. Install oxidizer duct plate EWR 972056 on inlet duct flange.

n. Using handler, relax compression on inlet duct so that inlet duct flange contacts Teflon sheet.

o. Using Stage Contractor procedures, remove bolts and washers that secure inlet duct to customer connect flange.

p. Compress duct to maximum allowed by handler.

q. Remove seal from customer connect flange.

r. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange and customer connect flange. Fasten in place with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

s. Raise and move inlet duct clear of Teflon sheet on turbopump inlet flange and customer connect flange, taking care not to bump or otherwise damage sealing surfaces.

t. Remove Teflon sheet and test plate from turbopump inlet flange.

u. Make sure turbopump inlet and flange are clean and free of damage.

v. Install oxidizer pump inlet flange adapter on turbopump inlet using 8 bolts and washers. Torque bolts to 25-30 in-lb.

w. Install pump inlet closure (paragraph 3-258) on adapter using 8 screws.

x. Remove oxidizer duct plate EWR 972056 from lower flange of inlet duct.

y. Make sure inlet duct and flange are clean and free of damage.

z. Install plate RK395-52111-003 (paragraph 3-258) on lower flange of inlet duct.

aa. Remove Aclar film and tape from customer connect flange and install protective closure as outlined by Stage Contractor procedures.

ab. Remove Aclar film and tape from upper flange of fuel inlet duct and install plate and inlet ducts closure (paragraph 3-258) using 12 screws and washers.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps aa through ad otherwise omit step z.

ac. Using hoist, transfer duct through stage access door and lower into component handling cart.

ad. Using hoist, transfer duct by stage access door and stow on protective pad.

ae. Remove angle adapter from hoist, and install chain-hoist.

af. Attach hoist hook to lifting ring on handler, and raise duct.

ag. Using hoist, transfer duct through stage access door and lower into component handling cart.

ah. Remove handler from inlet duct.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

- The use of the incorrect inlet duct supports can damage the engine.

ai. Using turnbuckles from inlet duct support frame installing tool kit 9025150 to adjust length of fuel inlet duct, install fuel inlet duct supports (minimum of 2) on inlet duct with hand knobs to right side of bipods when duct is viewed from inlet end.

aj. Remove turnbuckles from inlet duct bipods.

ak. Make sure inlet duct covers and inlet duct pads are installed.

3-222. REMOVING OXIDIZER INLET DUCT (STACKED SIVB STAGE). The oxidizer inlet duct (figure 3-56) may be replaced without affecting engine calibration. The procedure in paragraph 3-220, Removing Oxidizer Inlet Duct (Unstacked Stage), may be used if additional provisions are made to protect personnel from injury and equipment from damage in a stacked stage.

a. Install track and hoist run-in for oxidizer inlet duct removal, as required for applicable stage. (Refer to section V.) Install turntable with controls leading.

b. Obtain the following equipment:

(1) Oxidizer inlet duct handler 9016785-11.

(2) Torque wrench adapter T-5040045.

(3) Inlet duct support frame installing tool kit 9025150.

(4) Aclar No. 33C film (Allied Chemical Corp).

(5) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(6) Test plate 9022696-11.

(7) Teflon sheet EWR 915729.

(8) Oxidizer duct plate EWR 972056.

(9) Plate RX-20823-41.

(10) Oxidizer pump inlet flange adapter RX-19142-11.

(11) Pump inlet closure RX-20714.

(12) Plate RK395-52111-003.

(13) Inlet ducts closure RK395-10124 or -011.

(14) Oxidizer inlet duct supports RK395-44100-101 and/or -021.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Make sure torsional ring protective covers are installed on inlet duct.

e. Remove bolts and washers that secure inlet duct to turbopump inlet flange using torque wrench adapter only when necessary.

f. Record location and support the turbopump accelerometer and mount, and oxidizer bleed line and bracket as necessary.

g. Install handler on hoist, and position hoist approximately over PU valve.

h. Install handler on oxidizer inlet duct, jockeying handler into position by using hoist.

i. Compress duct to maximum allowed by handler.

j. Remove seal from turbopump inlet flange.

k. Make sure turbopump inlet and flange are clean and free of damage.

l. Install test plate 9022696-11 on turbopump inlet flange. Seal threaded port in center of test plate with pressure-sensitive tape RB0195-002 (Rocketdyne).

m. Place Teflon sheet on test plate.

n. Install oxidizer duct plate EWR 972056 on inlet duct flange.

o. Using handler, relax compression on inlet duct allowing inlet duct flange to contact Teflon sheet.

p. Using Stage Contractor procedures, remove bolts and washers that secure inlet duct to customer connect flange.

q. Compress duct to maximum allowed by handler.

r. Remove seal from customer connect flange.

s. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange and customer connect flange. Fasten in place with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

NOTE

The oxidizer inlet duct should move outward and upward on a radial line from the engine axis.

t. Raise and move inlet duct clear of turbopump inlet flange and customer connect flange, taking care not to bump or otherwise damage sealing surfaces.

u. Remove Teflon sheet and test plate from turbopump inlet flange.

v. Make sure turbopump inlet and flange are clean and free of damage.

w. Install oxidizer pump inlet flange adapter on turbopump inlet using 8 bolts and washers. Torque bolts to 25-30 in-lb.

x. Install pump inlet closure (paragraph 3-258) on adapter using 8 screws.

y. Remove oxidizer duct plate EWR 972056 from lower flange of inlet duct.

z. Make sure inlet duct and flange are clean and free of damage.

aa. Install plate RK395-52111-003 (paragraph 3-258) on lower flange of inlet duct.

ab. Remove Aclar film and tape from customer connect flange and install protective closure as specified in Stage Contractor procedures.

ac. Remove Aclar film and tape from upper flange of inlet duct and install plate and inlet ducts closure (paragraph 3-258) using 12 screws and washers.

ad. Using hoist, move oxidizer inlet duct to an accessible area near stage access door.

ae. Remove handler (with oxidizer inlet duct installed) from hoist. If oxidizer inlet duct is being removed to remove oxidizer turbopump, place oxidizer inlet duct and handler on a protective pad.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

- The use of the incorrect inlet duct supports can damage the engine.

af. Using turnbuckles from inlet duct support frame installing tool kit 9025150 to adjust length of fuel inlet duct, install fuel inlet duct supports (minimum of 2) on inlet duct with hand knobs to right side of bipods when duct is viewed from inlet end.

ag. Remove turnbuckles from inlet duct bipods.

ah. Make sure inlet duct covers and inlet duct pads are installed.

NOTE

The combined weight of the oxidizer inlet duct and handler is approximately 117 pounds.

ai. Using lifting eye on handler, manually carry oxidizer inlet duct from stage.

3-223. INSTALLING OXIDIZER INLET DUCT (ENGINE HANDLER). (See figure 3-56.)

a. Obtain the following equipment:

(1) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(2) Inlet duct sling 9024400.

(3) Torque wrench adapter T-5040045.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

Care must be taken when oxidizer inlet duct is installed on engines incorporating MD251 change, to prevent damage to insulation.

c. Make sure covers are installed on inlet duct if duct is not insulated.

d. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

e. Check inlet duct null-point index marks scribed in 3 places on circumference if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

f. Make sure six 1/8-inch holes in torsional ring are covered with pressure-sensitive tape RB0195-002 (Rocketdyne).

g. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

h. Remove inlet duct pads from inlet duct bipods.

CAUTION

The use of the incorrect inlet duct supports can damage the engine.

- The oxidizer inlet duct supports must be in place when using inlet duct sling 9024400, to prevent damage to the oxidizer inlet duct.

i. Attach inlet duct sling 9024400 to oxidizer inlet duct by looping 3 straps through inlet duct bipods. Connect snap fasteners.

j. Attach hoist to inlet duct sling 9024400, and position oxidizer inlet duct.

k. Install bonding jumper at each end of inlet duct using screws and washers.

l. Remove plate (paragraph 3-257) from lower flange of inlet duct.

m. Make sure inside of duct and duct sealing surfaces are clean and free of damage.

n. Remove pump inlet closure and oxidizer pump inlet flange adapter (paragraph 3-257) from turbopump inlet flange.

o. Make sure turbopump inlet and flange are clean and free of damage.

p. Place seal on turbopump inlet flange.

q. Install inlet duct on turbopump inlet flange, making sure that inlet duct flange pin seats in hole in turbopump inlet flange. Take care not to bump or otherwise damage sealing surfaces.

r. Install bolts and washers that secure inlet duct to turbopump inlet flange, attaching turbopump accelerometer mount, oxidizer bleed line bracket, and bonding jumper from inlet duct.

s. Remove oxidizer inlet duct sling 9024400 from oxidizer inlet duct.

t. Torque bolts to 110 +5 in-lb and safetywire. Use torque wrench adapter only when necessary.

u. On engines incorporating MD251 change, make sure insulation is installed on oxidizer inlet duct (paragraph 3-163).

v. Refer to section IV for test requirements.

3-224. INSTALLING OXIDIZER INLET DUCT (UNSTACKED STAGE). The oxidizer inlet duct (figure 3-56) may be reinstalled or replaced without affecting engine calibration. This procedure covers installation of the duct on engines installed in the SIVB stage and in positions 1 through 4 in the SII stage. Installation of the duct on an engine installed in position 5 in the SII stage must be done in accordance with applicable Stage Contractor procedures.

a. Obtain the following:

(1) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(2) Aclar No. 33C film (Allied Chemical Corp).

(3) Inlet duct support frame installing tool kit 9025150.

(4) Test plate 9022696-11.

(5) Teflon sheet EWR 915729.

(6) Oxidizer duct plate EWR 972056.

(7) Torque wrench adapter T-5040045.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure inlet duct covers are installed on inlet duct if duct is not insulated.

d. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

e. Check inlet duct null-point index marks scribed in 3 places on circumference if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

f. Make sure six 1/8-inch holes in torsional ring are covered with pressure-sensitive tape RB0195-002 (Rocketdyne).

g. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

h. Remove inlet duct pads from inlet duct bipods.

i. Remove inlet ducts closure and plate (paragraph 3-257) from upper flange of inlet duct.

j. Make sure inside of duct and sealing surfaces are clean and free of damage.

k. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange. Fasten with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

l. Remove plate (paragraph 3-257) from lower flange of inlet duct.

m. Make sure inside of duct and duct sealing surfaces are clean and free of damage.

n. Install oxidizer duct plate EWR 972056 on lower flange of inlet duct with bolts.

o. Install bonding jumper at each end of inlet duct using screws and washers.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

p. Install the 3 turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150 on inlet duct bipods.

q. Adjust the 3 turnbuckles evenly, in small increments, to remove tension or compression load on inlet duct support pin adapters, and remove oxidizer inlet duct supports.

r. Remove protective closure from customer connect flange as specified in Stage Contractor procedures.

s. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

t. Install protective material on customer connect flange as specified in Stage Contractor procedures.

u. Remove pump inlet closure and oxidizer pump inlet flange adapter (paragraph 3-257) from turbopump inlet flange.

v. Make sure turbopump inlet and flange are clean and free of damage.

w. Install test plate 9022696-11 on turbopump inlet flange using 4 bolts. Seal threaded port in center of test plate with pressure-sensitive tape RB0195-002 (Rocketdyne).

x. Place Teflon sheet EWR 915729 on test plate.

WARNING

Loose turnbuckles may become disengaged from fuel inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The inlet duct must not be compressed to less than 18.85 inches since damage can result.

y. Tighten the 3 turnbuckles evenly, in small increments, compressing inlet duct enough to provide clearance between customer connect flange and Teflon sheet on turbopump inlet flange. Do not compress inlet duct to less than 18.85 inches.

z. Using suitable equipment, raise and position inlet duct on Teflon sheet and aline inlet duct flange pin with hole in turbopump inlet flange. Make certain inlet duct clears customer connect flange, taking care not to bump or otherwise damage sealing surfaces.

aa. Remove protective material from customer connect flange.

ab. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

ac. Remove Aclar film and tape from upper flange of inlet duct.

ad. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

ae. Place seal on upper flange of inlet duct.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

af. Loosen the 3 turnbuckles evenly, in small increments, so that inlet duct flange contacts customer connect flange.

ag. Make sure inlet duct flange pin will seat in hole in turbopump inlet flange.

ah. Connect inlet duct to customer connect flange as specified in Stage Contractor procedures, making sure that bonding jumper from inlet duct is installed under one bolt.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

ai. Tighten the 3 turnbuckles evenly, in small increments, compressing inlet duct enough to install seal on turbopump inlet flange. Do not compress inlet duct to less than 18.85 inches.

aj. Remove oxidizer duct plate EWR 972056 from lower flange of inlet duct.

ak. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

al. Remove Teflon sheet and test plate from turbopump inlet flange.

am. Make sure turbopump inlet and flange sealing surfaces are clean and free of damage.

an. Place seal on turbopump inlet flange.

WARNING

Loose turnbuckles may become disengaged from inlet duct bipods and fall, causing injury to personnel and damage to equipment.

ao. Loosen the 3 turnbuckles evenly, in small increments, until inlet duct flange contacts turbopump inlet flange, making sure that inlet duct flange pin seats in hole in turbopump inlet flange.

ap. Remove the 3 turnbuckles from inlet duct bipods.

aq. Install bolts and washers that secure inlet duct to turbopump inlet flange, attaching turbopump accelerometer mount, oxidizer bleed line bracket, and bonding jumper from inlet duct.

ar. Torque bolts to 110 ±5 in-lb and safetywire. Use torque wrench adapter only when necessary.

as. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

at. Check inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

au. If insulation was removed, reinstall insulation on inlet duct (paragraph 3-163), except for torsional ring area.

av. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

aw. Refer to section IV for test requirements.

3-225. INSTALLING OXIDIZER INLET DUCT (STACKED SII STAGE). The oxidizer inlet duct (figure 3-56) may be reinstalled or replaced without affecting engine calibration. This procedure covers installation of the duct on engines installed in positions 1 through 4. Installation of the duct on an engine installed in position 5 must be done in accordance with applicable Stage Contractor procedures. The procedure in paragraph 3-22A, Installing Oxidizer Inlet Duct (Unstacked Stage), may be used if additional provisions are made to protect personnel from injury and equipment from damage in a stacked stage.

a. Obtain the following equipment: (Items 3 through 5 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Oxidizer inlet duct handler 9016785-11.

(2) Angle adapter 9027172 from Engine Components Installer G4071, shelf 2.

(3) Chain-hoist 9027095 from engine components installer set 9026251.

(4) Universal joint S8 from engine components installer set 9026251.

(5) Extension bar SX-24 from engine components installer set 9026251.

(6) Components handling cart 9026253-11 from engine components installer set 9026251.

(7) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm).

(8) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(9) Aclar No. 33C film (Allied Chemical Corp).

(10) Inlet duct support frame installing tool kit 9025150.

(11) Test plate 9022696-11.

(12) Teflon sheet EWR 915729.

(13) Oxidizer duct plate EWR 972056.

(14) Torque wrench adapter T-5040045.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure inlet duct covers are installed on inlet duct if duct is not insulated.

d. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

e. Check inlet duct null-point index marks scribed in 3 places on circumference if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

f. Make sure six 1/8-inch holes in torsional ring are covered with pressure-sensitive tape RB0195-002 (Rocketdyne).

g. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

h. Remove inlet duct pads from inlet duct bipods.

i. Install turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150 on oxidizer inlet duct.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

j. Adjust turnbuckles to remove tension or compression load on inlet duct support pin adapters, and remove supports. Tunrbuckles can be removed one at a time to aid removal of each support; then reinstalled before removing next support.

k. Remove the 3 turnbuckles and install handler on oxidizer inlet duct, positioned so that bleed plugs on inlet duct are alined with, and adjacent to, handler adapter. Using handler, compress inlet duct to maximum allowed by handler.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps l through o.

l. Install chain-hoist to hoist boom and extend hoist boom through stage access door.

m. Lower hoist hook and attach to lifting ring of handler.

n. Using hoist, raise duct and transfer duct in through stage access door and place duct on protective pad.

o. Remove hoist from hoist boom.

p. Install angle adapter on boom. (See figure 3-6, view E.)

q. Connect handler to hoist, and position hoist at track station 20 for engine positions 1 through 4.

r. Remove inlet ducts closure and plate (paragraph 3-257) from upper flange of inlet duct.

s. Make sure inside of duct and sealing surfaces are clean and free of damage.

t. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange. Fasten with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

u. Remove plate (paragraph 3-257) from lower flange of inlet duct.

v. Make sure inside of duct and duct sealing surfaces are clean and free of damage.

w. Install oxidizer duct plate EWR 972056 on lower flange of inlet duct with bolts.

x. Remove protective closure from customer connect flange as specified in Stage Contractor procedures.

y. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

z. Install protective material on customer connect flange as specified in Stage Contractor procedures.

aa. Remove pump inlet closure and oxidizer pump inlet flange adapter (paragraph 3-257) from turbopump inlet flange.

ab. Make sure turbopump inlet and flange are clean and free of damage.

ac. Install test plate 9022969-11 on turbopump inlet flange with bolts. Seal threaded port in center of test plate with pressure-sensitive tape RB0195-002 (Rocketdyne).

ad. Place Teflon sheet on test plate installed on turbopump inlet flange.

ae. Compress duct to maximum allowed by handler.

af. Using hoist, raise and position inlet duct on Teflon sheet and aline inlet duct flange pin with hole in turbopump inlet flange. Make certain inlet duct clears customer connect flange, taking care not to bump or otherwise damage sealing surfaces.

ag. Remove protective material from customer connect flange.

ah. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

ai. Remove Aclar film and tape from upper flange of inlet duct.

aj. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

ak. Place seal on upper flange of inlet duct.

al. Using handler, relax compression on inlet duct making sure that fuel inlet duct flange contacts customer connect flange.

am. Make sure inlet duct flange pin will seat in hole in turbopump inlet flange.

an. Connect inlet duct to customer connect flange as specified in Stage Contractor procedures, making sure that bonding jumper from inlet duct is installed under one bolt.

ao. Compress duct to maximum allowed by handler.

ap. Remove plate from inlet duct flange.

aq. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

ar. Remove Teflon sheet and test plate from turbopump inlet flange.

as. Make sure turbopump inlet and flange sealing surfaces are clean and free of damage.

at. Place seal on turbopump inlet flange.

au. Using handler, relax compression on inlet duct until inlet duct flange contacts turbopump inlet flange, making sure that inlet duct flange pin seats in hole in turbopump inlet flange.

av. Remove handler from oxidizer inlet duct.

aw. Install bolts and washers that secure inlet duct to turbopump inlet flange, attaching turbopump accelerometer mount, oxidizer bleed line bracket, and bonding jumper from inlet duct.

ax. Torque bolts to 110±5 in-lb and safetywire. Use torque wrench adapter only when necessary.

ay. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

az. Check inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

ba. If insulation was removed, reinstall insulation on inlet duct (paragraph 3-163), except on torsional ring.

bb. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

bc. Refer to section IV for test requirements.

3-226. INSTALLING OXIDIZER INLET DUCT (STACKED SIVB STAGE). The oxidizer inlet duct (figure 3-56) may be reinstalled or replaced without affecting engine calibration. The procedure in paragraph 3-224, Installing Oxidizer Inlet Duct (Unstacked Stage), may be used if additional provisions are made to protect personnel from injury and equipment from damage in a stacked stage.

a. Obtain the following equipment:

(1) Pressure-sensitive tape RB0135-002 (Rocketdyne).

(2) Aclar No. 33C film (Allied Chemical Corp).

(3) Test plate 9022696-11.

(4) Teflon sheet EWR 915729.

(5) Oxidizer duct plate EWR 972056.

(6) Oxidizer inlet duct handler 9016785-11.

(7) Torque wrench adapter T-5040045.

(8) Inlet duct support frame installing tool kit 9025150.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Make sure inlet duct covers are installed on inlet duct if duct is not insulated.

d. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

e. Check inlet duct null-point index marks scribed in 3 places on circumference if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

f. Make sure six 1/8-inch holes in torsional ring are covered with pressure-sensitive tape RB0195-002 (Rocketdyne).

g. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

h. Remove inlet duct pads from inlet duct bipods.

i. Install turnbuckles 9026636 from inlet duct support frame installing tool kit 9025150 on oxidizer inlet duct.

CAUTION

The duct must not be compressed to less than 18.85 inches since damage can result.

j. Adjust turnbuckles to remove tension or compression load on inlet duct support pin adapters, and remove supports. Turnbuckles can be removed one at a time to aid removal of each support, then reinstalled before removing next support.

k. Manually carry oxidizer inlet duct into stage. A suggested method of handling duct is to install handler on duct. Position handler so that bleed plugs on duct are adjacent to handler adapter socket.

l. Remove inlet duct closure and plate (paragraph 3-257) from upper flange of inlet duct.

m. Make sure inside of duct and sealing surfaces are clean and free of damage.

n. Install Aclar No. 33C film (Allied Chemical Corp) on inlet duct flange. Fasten with pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

o. Remove plate (paragraph 3-257) from lower flange of inlet duct.

p. Make sure inside of duct and duct sealing surfaces are clean and free of damage.

q. Install oxidizer duct plate EWR 972056 on lower flange of inlet duct using bolts.

r. Install bonding jumper at each end of inlet duct using screws and washers.

s. Remove protective closure from customer connect flange as specified in Stage Contractor procedures.

t. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

u. Install protective material on customer connect flange as specified in Stage Contractor procedures.

v. Remove pump inlet closure and oxidizer pump inlet flange adapter (paragraph 3-257) from turbopump inlet flange.

w. Make sure turbopump inlet and flange are clean and free of damage.

x. Install test plate 9022696-11 on turbopump inlet flange with bolts. Seal threaded port in center of test plate with pressure-sensitive tape RB0195-002 (Rocketdyne).

y. Place Teflon sheet on test plate.

z. Install handler on hoist and secure with ball-lock pin. If duct is not installed in handler, install duct so that bleed plugs are adjacent to handler adapter socket.

aa. Using handler, compress oxidizer inlet duct to maximum allowed by handler.

ab. Using hoist, move oxidizer inlet duct to engine and orient duct for installation.

ac. Using suitable equipment, raise and position inlet duct on Teflon sheet and aline inlet duct flange pin with hole in turbopump inlet flange. Make certain inlet duct clears customer connect flange, taking care not to bump or otherwise damage sealing surfaces.

ad. Remove protective material from customer connect flange.

ae. Make sure inside of customer connect and sealing surfaces of flange are clean and free of damage.

af. Remove Aclar film and tape from upper flange of inlet duct.

ag. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

ah. Place seal on upper flange of inlet duct.

ai. Using handler, relax compression on inlet duct so that inlet duct flange contacts customer connect flange.

aj. Make sure inlet duct flange pin will seat in hole in turbopump inlet flange.

ak. Connect inlet duct to customer connect flange as specified in Stage Contractor procedures, making sure that bonding jumper from inlet duct is installed under one bolt.

al. Compress duct to maximum allowed by handler.

am. Remove plate (paragraph 3-257) from inlet duct flange.

an. Make sure inlet duct interior and flange sealing surfaces are clean and free of damage.

ao. Remove Teflon sheet and test plate from turbopump inlet flange.

ap. Make sure turbopump inlet and flange sealing surfaces are clean and free of damage.

aq. Place seal on turbopump inlet flange.

ar. Using handler, relax compression on inlet duct until inlet duct flange contacts turbopump inlet flange, making sure that inlet duct flange pin seats in hole in turbopump inlet flange.

as. Remove handler from inlet duct.

at. Install bolts and washers that secure inlet duct to turbopump inlet flange, attaching turbopump accelerometer mount, oxidizer bleed line bracket, and bonding jumper from inlet duct.

au. Torque bolts to 110 ±5 in-lb and safetywire. Use torque wrench adapter only when necessary.

av. Remove torsional ring protective covers (paragraph 3-257A) from inlet duct.

aw. Check inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-1B.

ax. Install torsional ring protective covers (paragraph 3-258A) on inlet duct.

ay. Refer to section IV for test requirements.

az. Disassemble track (section V).

3-227. OXIDIZER TURBINE BYPASS VALVE.

3-228. REMOVING OXIDIZER TURBINE BYPASS VALVE. (See figure 3-57.)

a. Obtain the following:

(1) Test plate 9020251-11 from test plate kit 9016723-11.

(2) Upper bracket 9021015 from bypass valve removal tool kit 9020269.

(3) Lower bracket 9021016 from bypass valve removal tool kit 9020269.

(4) Bolts AN103811 from bypass valve removal tool kit 9020269.

(5) Washers LD153-0011-0014 from bypass removal tool kit 9020269.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Disconnect electrical connector (paragraph 3-30) P117.

d. Disconnect opening control line, remove seal and orifice, and install clean protective closures (paragraph 3-258).

e. Disconnect closing control line, remove seal, and install clean protective closure (paragraph 3-258) on closing control line.

i. Install test plate on closing control port.

g. Connect a pressure hose between test plate and a regulated pneumatic source of helium capable of supplying 425 psig.

h. Apply 400 ±25 psig to valve closing control port. Bypass valve closes.

CAUTION

The valve must be in closed position during removal to prevent damage to the orifice nozzle or the valve gate.

i. Remove 3 valve-retaining nuts, washers, and bolts nearest two 1/4-inch holes in exhaust duct flange and thrust chamber flange.

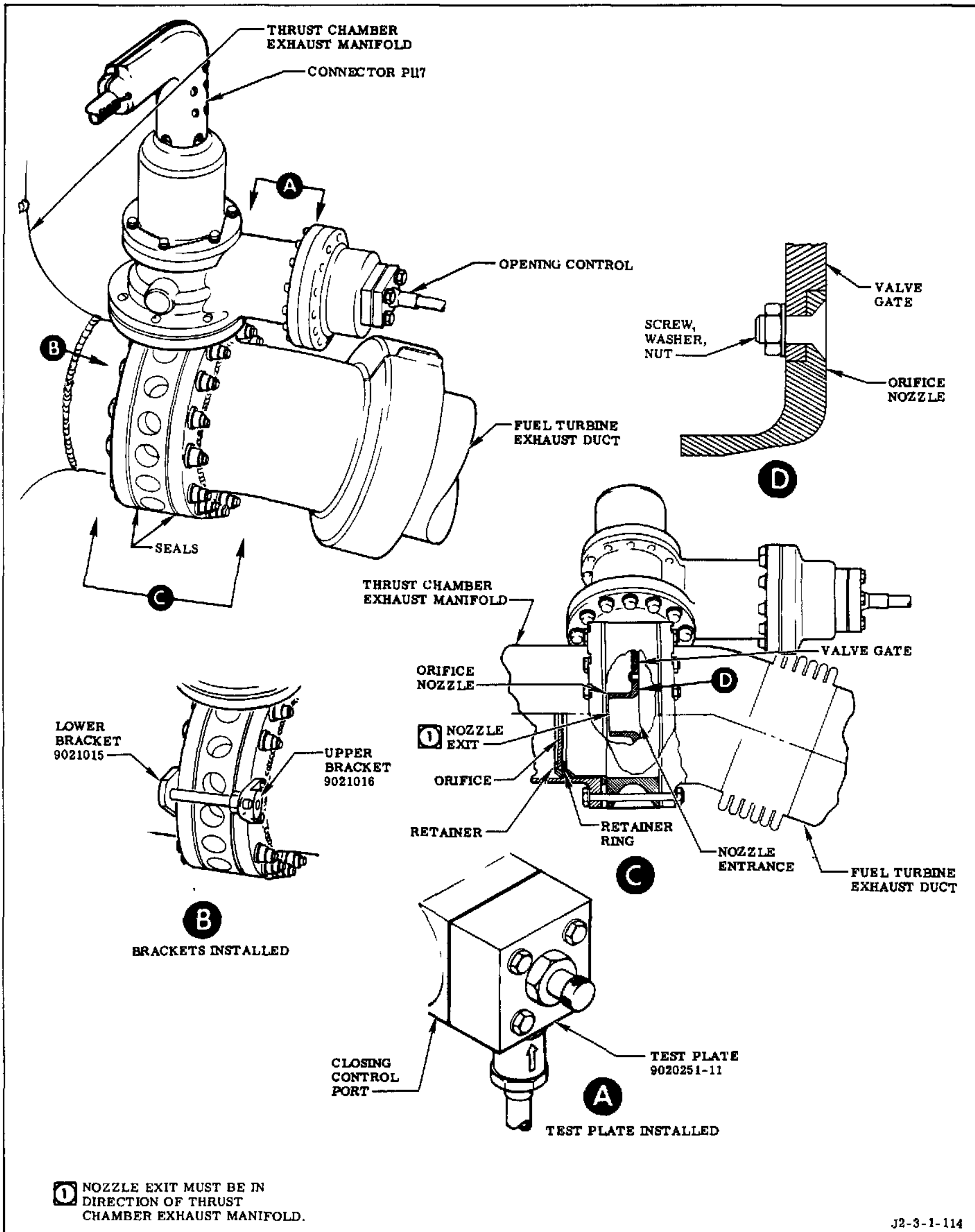


Figure 3-57. Oxidizer Turbine Bypass Valve, Orifice Nozzle, Orifice Plate, and Retainer

j. Install upper bracket on exhaust duct flange, with boss of bracket facing away from valve, and secure bracket with bolts and washers.

k. Insert extended portion of lower bracket into upper bracket, and secure lower bracket to thrust chamber flange with bolts and washers. Make sure extension of lower bracket is at minimum length before installation.

l. Remove remaining nuts, washers, and bolts from valve except for a sufficient number to support valve when exhaust duct is compressed. Loosen remaining bolts to allow compression of duct.

m. Rotate hex extension of lower bracket until duct bellows are compressed enough to remove valve and seals.

n. Support valve and remove remaining nuts, washers, and bolts. Remove valve and seals noting position of valve for reinstallation.

o. Reduce pneumatic pressure to valve closing control port. Open bleed valve on test plate and vent pressure. When pressure has vented, remove test plate and install clean protective closures (paragraph 3-258) on valve and open ducts of engine.

p. On engines incorporating MD293 change, if OTBV is replaced, remove accelerometer mounting block and retain for installation on new valve.

q. If OTBV is replaced, remove orifice nozzle (paragraph 3-231) and retain for installation on new valve.

3-229. INSTALLING OXIDIZER TURBINE BYPASS VALVE. (See figure 3-57.)

a. Obtain the following:

(1) Test plate 9020251-11 from test plate kit 9016723-11.

(2) Upper bracket 9021015 from bypass valve removal tool kit 9020269.

(3) Lower bracket 9021016 from bypass valve removal tool kit 9020269.

(4) Bolts AN103811 from bypass valve removal tool kit 9020269.

(5) Washers LD153-0011-0014 from bypass valve removal tool kit 9020269.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. If installing a replacement valve, remove protective closures (paragraph 3-257) from valve and install orifice nozzle previously retained (paragraph 3-232). Reinstall protective closures (paragraph 3-258).

d. On engines incorporating MD293 change, if OTBV is replaced, install accelerometer mounting block as follows:

(1) Cut lockwire and remove bleed plug and gasket from downstream side of valve.

(2) Using sealing and antiseize compound RB0140-005 (Rocketdyne), lubricate (Method A, section I) external threads of accelerometer mounting block.

(3) Install accelerometer mounting block in bleed plug port. Do not install gasket. Torque accelerometer mounting block to 30-35 in-lb. Base of block must aline within ±15 degrees of valve flange. Add shims 707747 (3 maximum) as necessary to obtain required alinement.

(4) Safetywire acceleromter mounting block to remaining bleed plug.

e. Remove protective closures (paragraph 3-257) from thrust chamber exhaust manifold and fuel turbine exhaust duct.

f. Make sure manifold, duct, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

g. Install upper bracket on exhaust duct flange, and secure bracket with bolts and washers. (Boss of bracket must face away from duct flange.)

h. Make sure extension of lower bracket is at minimum length; then insert into upper bracket. Secure lower bracket to thrust chamber flange with bolts and washers.

i. Rotate hex portion of lower bracket until turbine exhaust duct is compressed enough to allow valve and seals to be installed.

j. Install test plate on bypass valve closing control port.

k. Connect a pressure hose between test plate and a regulated pneumatic source of helium capable of supplying 425 psig.

l. Apply 400 ±25 psig to valve closing control port. Bypass valve closes. The valve must be in a closed position for installation.

m. Remove protective closures from bypass valve, and install and position valve and seals using bolts for alinement.

n. Rotate hex extension of removal tool to allow exhaust duct bellows to expand into position.

o. Remove brackets and install remaining bolts, washers, and nuts. Insert bolts from thrust chamber side, except for one bolt on inboard side of duct (next to drain boss), which must be installed from exhaust duct side.

p. Torque nuts to 76-84 in-lb.

q. Reduce pneumatic pressure to valve closing control port. Open bleed valve on test plate and vent pneumatic pressure. When pressure has vented, remove pressure hose and test plate.

r. Remove protective closure (paragraph 3-257) from closing control line.

s. Install seal on bypass valve closing control port, and connect closing control line to closing control port with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

t. Remove protective closures (paragraph 3-257) from opening control line and opening control port.

u. Install orifice and seal, and connect opening control line to bypass valve opening control port with bolts and washers. Install orifice with cupped side toward OTBV. Torque bolts to 41-45 in-lb and safetywire.

v. Connect electrical connector (paragraph 3-31) P117.

w. On engines incorporating MD292 change, insulate (paragraph 3-169) OTBV.

x. Refer to section IV for test requirements.

3-230. OXIDIZER TURBINE BYPASS VALVE ORIFICE NOZZLE.

3-231. REMOVING OXIDIZER TURBINE BYPASS VALVE ORIFICE NOZZLE. The OTBV orifice nozzle (figure 3-57) may be removed and reinstalled but cannot be replaced without affecting engine calibration.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove OTBV (paragraph 3-228).

c. Remove screws, washers, and nuts that secure orifice nozzle to OTBV gate; then remove orifice nozzle.

d. Install clean protective closures (paragraph 3-258) on OTBV.

e. If orifice nozzle is not immediately reinstalled, it must be protected to prevent damage or contamination.

3-232. INSTALLING OXIDIZER TURBINE BYPASS VALVE ORIFICE NOZZLE. The OTBV orifice nozzle (figure 3-57) may be reinstalled but cannot be replaced without affecting engine calibration.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove closures (paragraph 3-257) from OTBV and protective material from OTBV orifice nozzle, if existing. Make sure OTBV and orifice nozzle are clean and free of damage.

CAUTION

Incorrect nozzle installation will affect engine calibration.

c. Install and secure orifice nozzle on OTBV gate with nozzle exit in direction of thrust chamber exhaust manifold (figure 3-57) with washers, screws, and nuts. Torque nuts to 25-30 in-lb.

d. Install OTBV (paragraph 3-229).

3-233. <u>OXIDIZER TURBINE BYPASS VALVE ORIFICE PLATE, RETAINER, AND RETAINER RING.</u>

3-234. REMOVING OXIDIZER TURBINE BYPASS VALVE ORIFICE PLATE, RETAINER, AND RETAINER RING. The OTBV orifice plate, retainer, and retainer ring (figure 3-57) may be removed and reinstalled but cannot be replaced without affecting engine calibration.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove OTBV (paragraph 3-228).

c. Remove retaining ring, orifice plate, and retainer from thrust chamber exhaust manifold (figure 3-57).

NOTE

The retaining ring, orifice plate, and retainer are removed on engines incorporating MD227 change.

d. If retaining ring, orifice plate, and retainer are not immediately reinstalled, protect them with clean protective material.

3-235. INSTALLING OXIDIZER TURBINE BYPASS VALVE ORIFICE PLATE, RETAINER, AND RETAINER RING. The OTBV orifice plate, retainer, and retainer ring (figure 3-57) may be reinstalled but cannot be replaced without affecting engine calibration.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from OTBV and protective material from OTBV orifice plate, retainer, and retainer ring, if existing. Make sure OTBV, orifice plate, retainer, and retainer ring are clean and free of damage.

c. Install retaining ring, orifice plate, and retainer in thrust chamber exhaust manifold (figure 3-57).

d. Install OTBV (paragraph 3-229).

3-235A. <u>OXIDIZER TURBINE BYPASS VALVE POSITION INDICATOR.</u>

3-235B. REMOVING OXIDIZER TURBINE BYPASS VALVE POSITION INDICATOR. (See figure 3-57A.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

NOTE

Steps b and c make sure the OTBV is in the fully open position.

b. Energize helium control valve, and pressurize engine helium tank with helium to 225-250 psig.

c. Depressurize system by decreasing pressure to helium tank to zero, allowing pressure to vent from helium tank, and deenergizing helium control valve.

d. Disconnect electrical connector (paragraph 3-30) P117 (16).

e. Remove screws (1), washers (2), and lug (3), and separate position-indicator housing (5) from switch mount (18). Care must be exercised to prevent damage to wiring.

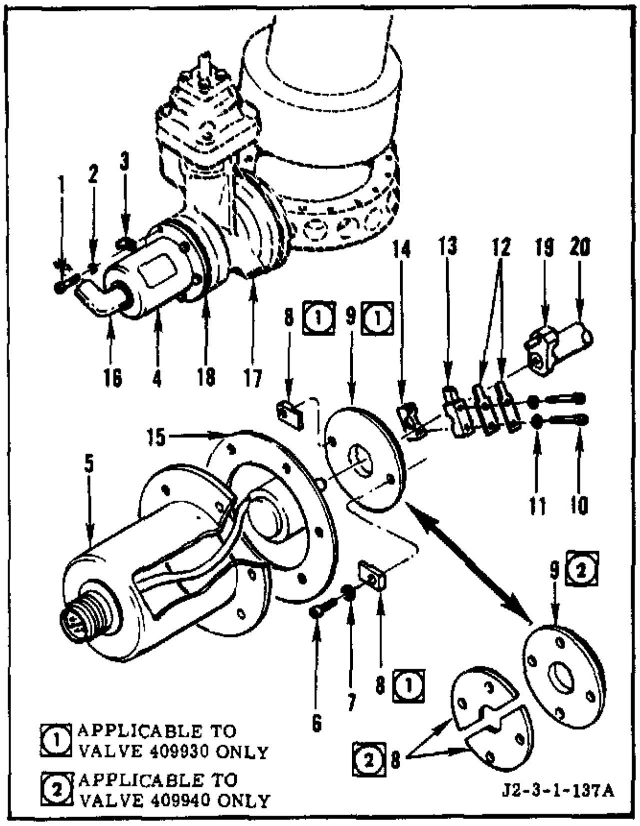
f. Remove screws (6), washers (7), and clips (8).

g. Lift items (5) and (9) through (15) from end of OTBV shaft.

h. Remove screws (10), washers (11), transducer arm springs (12), instrument-actuating arm (13), and instrument-actuating arm clamp (14) from shaft of resistor and switch assembly (4).

i. Protect and retain items (6) through (14) for reinstallation on OTBV.

j. If position indicator resistor and switch assembly (4) is not immediately reinstalled, protect OTBV and position indicator with clean protective material.



Index No.	Description
1	Screw
2	Washer
3	Lug
4	Resistor and switch assembly
5	Position-indicator housing
6	Screw
7	Washer
8	Clip
9	Position-indicator base
10	Screw
11	Washer
12	Transducer arm spring
13	Instrument-actuating arm
14	Instrument-actuating arm clamp
15	Flange seal
16	Electrical connector
17	Actuator housing
18	Switch mount
19	Actuator position-indicator arm
20	Shaft

Figure 3-57A. Oxidizer Turbine Bypass Valve Position Indicator

3-235C. INSTALLING OXIDIZER TURBINE BYPASS VALVE POSITION INDICATOR. (See figure 3-57A.)

a. *When performing this procedure, observe* safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective material from OTBV and from position indicator resistor and switch assembly (4). Make sure OTBV and position indicator are clean and free of damage.

c. Remove protective material from items (6) through (14) that were retained for reinstallation. Make sure items (6) through (15) are clean and free of damage.

d. Install position-indicator base (9) in place over potentiometer shaft of resistor and switch assembly (4).

e. Assemble 2 transducer arm springs (12), instrument-actuating arm (13), and instrument-actuating arm clamp (14) with 2 washers (11) and 2 screws (10), and install on potentiometer shaft with bar of clamp (14) against flat on shaft and in position shown. Torque screws to 30-38 in-oz and safetywire.

f. Install flange seal (15) on switch mount (18) on actuator housing (17).

g. Install position-indicator base (9) on switch mount (18), and at same time match slot in arm assembly on potentiometer shaft with pin of actuator position-indicator arm (19) on shaft (20). Do not allow undue strain on wiring of resistor and switch assembly (4) while assembling components. Secure in position with clips (8), washers (7), and screws (6). Tighten screws (6) fingertight.

gA. Pressurize helium tank with helium to 225-250 psig. Momentarily energize helium control valve.

h. Adjust resistor and switch assembly (4) as follows:

(1) Connect Wheatstone bridge to pins B and C of electrical connector J117 (16). With OTBV in normally open position, rotate resistor and switch assembly until a resistance of 500 ±10 ohms is obtained. Do not allow undue strain on wiring of switch assembly while adjusting resistor and switch assembly.

(2) Torque screws (6) to 56-70 in-oz to secure position-indicator base. Reverify resistance of 500 ±10 ohms; then safetywire screws (6).

i. Install position-indicator housing (5), alining flange seal (15) and positioning key of electrical connector (16) and lug (3) at 3 o' clock position with valve actuator cap at 12 o' clock position as viewed from switch end of valve. Install washers (2) and screws (1), and torque screws to 27-32 in-lb.

iA. Verify helium tank pressure of 225-250 psig, then energize helium control valve.

iB. Measure resistance between pins B and C of electrical connector J117. Resistance must be 500 ±30 ohms.

iC. Depressurize helium tank by decreasing pressure supply to helium tank to zero, allow pressure to vent from tank; and then deenergize helium control valve.

j. Connect electrical connector (paragraph 3-31) P117 (6).

k. Refer to section IV for test requirements.

3-236. OXIDIZER TURBOPUMP.

3-237. REMOVING OXIDIZER TURBOPUMP (ENGINE HANDLER OR UNSTACKED STAGE). The oxidizer turbopump (figure 3-58) may be removed and reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

CAUTION

Care must be taken when the oxidizer turbopump is removed from engines incorporating MD251 or MD252 change, to prevent damage to insulation.

a. If engine is in an unstacked stage, obtain suitable handling equipment to support and lift turbopump (304 pounds), and obtain pin puller CJ-93 (Snap-On-Tool Co).

b. If engine is in handler, obtain the following equipment:

(1) Turbopump Sling G4046 or Turbopump Rotating Sling G4063. (Turbopump rotating sling G4063 is required when turbopump is to be rotated from horizontal to vertical position after removal.)

(2) Oxidizer pump inlet flange adapter RX19142-11

(3) Oxidizer pump discharge flange adapter RX19141-11

(4) Pin puller CJ-93 (Snap-On-Tool Co)

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove oxidizer inlet duct on engines installed in handler (paragraph 3-219) and on engines in an unstacked stage (paragraph 3-220).

NOTE

Figure 3-52 illustrates the parts removed in steps dA, dB, and dC.

dA. Remove oxidizer bleed line flange bolts and washers at oxidizer bleed valve and remove seal. Leave small brackets attached to line and harness.

dB. Remove screw, washer, nut, and clamp at standoff bracket.

dC. Remove screw, washer, spacer, nut, and clamp at oxidizer turbopump support.

e. Remove PU valve (paragraph 3-254) or MRCV (paragraph 3-195B).

f. On engines not incorporating MD105 and MD194 change, disconnect heat exchanger antiflood check valve as follows:

(1) Using adapter T-5044632, remove bolts and washers that secure antiflood check valve to heat exchanger.

(2) Remove seal, and protect open ports and sealing surfaces.

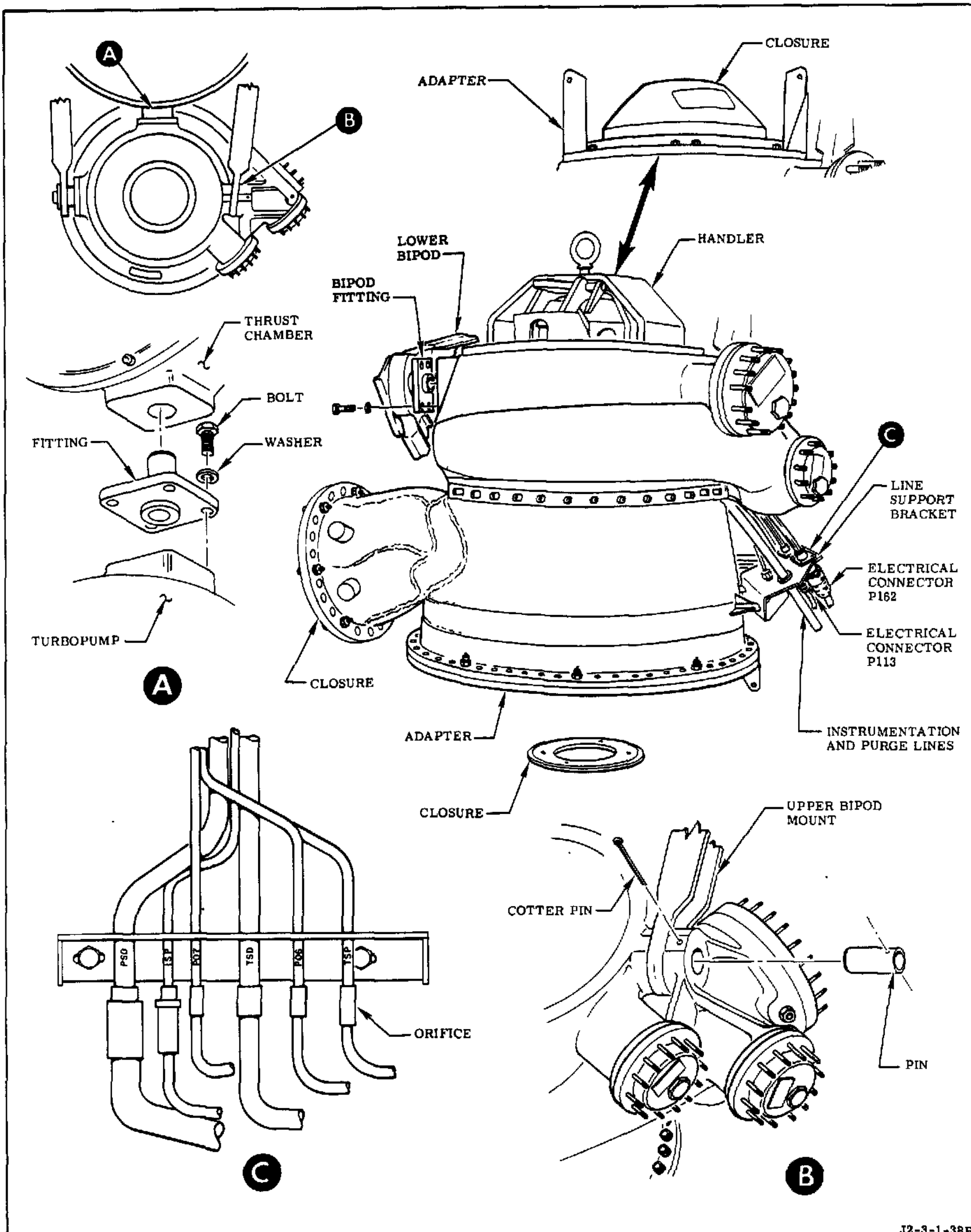


Figure 3-58. Oxidizer Turbopump

g. On engines incorporating MD105 and MD194 change, disconnect heat exchanger bypass line by removing bolts and washers that secure bypass line to support. Remove seal, and protect open ports and sealing surfaces.

h. On engines incorporating MD105 and MD194 changes, disconnect helium inlet line by removing bolts, washers, and support that secure helium inlet line to heat exchanger. Remove seal, and protect open ports and sealing surfaces.

i. Remove heat exchanger (paragraph 3-121).

j. Remove bolts and washers that secure oxidizer high-pressure duct to oxidizer turbopump only. Remove brackets and seal.

k. Disconnect electrical connectors (paragraph 3-30) P113, P127, and P162.

l. Cut the following lines (items 7 and 8 not applicable to engines J-2087 and J-2120 unless MD282 change is incorporated): (See figure 3-58. Refer to section VI for tube cutting requirements. Cut lines on downstream (engine side) of bracket, leaving approximately one inch of straight line downstream of first bend. Protect open end of cut lines.)

(1) Primary seal drain line (PSD)

(2) Intermediate seal purge line (ISP)

(3) Instrumentation line (PO7)

(4) Turbine seal drain line (TSD)

(5) Instrumentation line (PO6)

(6) Turbine seal purge line (TSP)

(7) Redundant instrumentation line (TF1) (removal of section required)

(8) Redundant instrumentation line (NN1) (removal of section required)

m. Cut oxidizer turbine inlet pressure line (TG3). (Refer to section VI for tube cutting requirements. Protect open end of cut lines.)

n. On engines incorporating MD302 or MD323 change, cut oxidizer pump drain customer connect line. (Refer to section VI for tube cutting requirements. Protect open end of cut lines.)

o. Remove bolts, washers, and nuts that secure fuel turbine exhaust duct to oxidizer turbopump. Remove brackets and seal. Protect openings and sealing surfaces.

p. If engine is installed in engine handler perform steps n through p, then proceed to step r. If engine is in an unstacked stage proceed to step p.

q. Install adapter RX19142 and RX19141 on oxidizer turbopump (figure 3-58) if not previously installed. Torque bolts securing adapters to 25-30 in-lb. Install clean protective closures (paragraph 3-258).

r. Install Turbopump Sling G4046 or Turbopump Rotating Sling G4063 on adapters. (See figure 3-22 when using G4063.)

s. Attach a hoist capable of lifting a minimum of 350 pounds to turbopump sling.

WARNING

Failure to provide adequate support and handling equipment for the turbopump can result in injury to personnel and damage to equipment.

t. Attach suitable equipment to lift and support oxidizer pump. The oxidizer pump weighs 304 pounds.

u. Remove bolts and washers that secure bipod fitting to oxidizer turbopump and move bipod fitting away from turbopump. (See figure 3-58.) It may be necessary to rotate bipod fitting to extract it from turbopump.

v. Remove cotter pin, and using pin puller remove pin that secures oxidizer turbopump to upper bipod mount. (See figure 3-58, detail B.)

w. Move oxidizer turbopump away from thrust chamber until turbopump center mount fitting is disengaged from bearing on thrust chamber. If fitting cannot be disengaged from thrust chamber, remove 4 bolts that secure fitting to turbopump; then remove turbopump and fitting from engine. (See figure 3-58, detail A.)

x. Carefully remove pump from engine.

y. Remove protective material from turbopump and engine ports; install clean protective closures (paragraph 3-258).

3-238. REMOVING OXIDIZER TURBOPUMP (STACKED SII STAGE). The oxidizer turbopump may be removed and reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment: (Items 6 through 10 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Oxidizer heat exchanger handler 9016790-11

(2) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4071, shelf 3

(3) Hook 9024600 from Engine Components Installer G4071, shelf 1

(4) Pin puller CJ-93 (Snap-On Tool Co)

(5) Torque wrench adapter T-5040045

(6) Pickup adapter 9024547 from engine components installer set 9026251

(7) Hanger 9024543 from engine components installer set 9026251

(8) Chain-hoist 9027095 from engine components installer set 9026251

(9) Universal joint S8 from engine components installer set 9026251

(10) Extension bar SX-24 from engine components installer set 9026251

(11) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(12) Components handling cart 9026253-11 from engine components installer set 9026251

(13) Ramps 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track (section V) around engine from which oxidizer turbopump is to be removed. Install turntable with controls leading, and position hoist at track station 15.5 for engine positions 1 through 4, or track station 16 for engine position 5.

d. Install hook on hoist in position shown in figure 3-6, view A.

e. Remove oxidizer inlet duct for engine positions 1 through 4 (paragraph 3-211), and for engine position 5 in accordance with applicable Stage Contractor procedures. Install handler 9026977 on oxidizer turbopump volute with handler arrow pointing toward oxidizer turbopump engine attach fitting. Using torque wrench adapter, cross-torque handler attach bolts to 90-110 in-lb. Install closure RX20714 on handler.

NOTE

Figure 3-52 illustrates the parts removed in steps eA, eB, and eC.

eA. Remove oxidizer bleed line flange bolts and washers at oxidizer bleed valve and remove seal. Leave small brackets attached to line and harness.

eB. Remove screw, washer, nut, and clamp at standoff bracket.

eC. Remove screw, washer, spacer, nut, and clamp at oxidizer turbopump support.

f. Remove PU valve (paragraph 3-254) or MRCV (paragraph 3-195B).

g. Remove bolts and washers that secure oxidizer high-pressure duct to oxidizer turbopump. Remove seal, and protect openings and sealing surfaces. Retain brackets for reinstallation.

h. Disconnect electrical connectors (paragraph 3-30) P113, P127, and P162. (See figure 3-58.)

i. Cut the following lines (items 7 and 8 not applicable to engines J-2087 and J-2120 unless MD282 change is incorporated): (See figure 3-58. Refer to section VI for tube cutting requirements. Cut lines on downstream engine side of bracket, leaving approximately one inch of straight line downstream of first bend. Protect open end of cut lines.)

(1) Primary seal drain line (PSD)

(2) Intermediate seal purge line (ISP)

(3) Instrumentation line (PO7)

(4) Turbine seal drain line (TSD)

(5) Instrumentation line (PO6)

(6) Turbine seal purge line (TSP)

(7) Redundant instrumentation line (TF1) (removal of section required)

(8) Redundant instrumentation line (NN1) (removal of section required)

j. Cut oxidizer turbine inlet pressure tube (TG3). (Refer to section IV for tube cutting requirements.) Protect open end of cut lines.

k. On engines incorporating MD302 or MD323 change, cut oxidizer pump drain customer connect line. (Refer to section IV for tube cutting requirements.) Protect open end of cut lines.

l. Remove bolts, washers, and nuts that secure fuel turbine exhaust duct to oxidizer turbopump. Remove bracket and seal. Protect openings and sealing surfaces. Retain brackets for reinstallation.

m. Install handler 9016790-11 on heat exchanger with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine.

n. Remove bolts and washers that secure bracket to oxidizer pump torque access plate.

o. Remove bolts and washers that secure heat exchanger to oxidizer turbopump.

p. Compress heat exchanger bellows by turning handknobs on heat exchanger handler. Remove seal at turbopump exhaust flange. Protect openings and sealing surfaces.

q. If launch tower umbilical arm is not to be used to remove turbopump from stage, install pickup adapter to handler lifting eye.

r. Connect hoist to turbopump and secure with ball-lock pin. Support weight of turbopump.

s. Remove bolts and washers that secure bipod fitting to oxidizer turbopump and move bipod fitting away from turbopump. (See figure 3-58.) It may be necessary to rotate bipod fitting to extract it from turbopump.

t. Remove cotter pin and, using pin puller remove pin that secures oxidizer turbopump to upper bipod mount. (See figure 3-58, detail B.)

u. Move turbopump away from thrust chamber until turbopump center mount fitting is disengaged from bearing on thrust chamber. If fitting cannot be disengaged from thrust chamber, remove 4 bolts that secure fitting to turbopump; then remove turbopump and fitting from engine. (See figure 3-58, detail A.)

v. Remove protective material from turbopump and engine ports; install clean protective closures (paragraph 3-258) on all open ports.

w. If launch tower umbilical arm is not to be used for transporting turbopump from stage, move turbopump to hanger and attach turbopump to hanger pickup adapter swivel. Remove hook from hoist boom, install chain-hoist on hoist boom, and attach hoist hook to pickup adapter, using shackle.

x. Using hoist, raise turbopump, transfer turbopump through stage access door, and slowly lower into component handling cart.

3-239. REMOVING OXIDIZER TURBOPUMP (STACKED SIVB STAGE). The oxidizer turbopump may be removed and reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment:

(1) Oxidizer heat exchanger handler 9016790-11

(2) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4072, shelf 3

(3) Hook 9024600 from Engine Components Installer G4072, shelf 3

(4) Pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(5) Hanger 9024543 from Engine Components Installer G4072, shelf 2

(6) Adapter 9026997 from engine components installer set 9026252

(7) Chain-hoist 9027095 from engine components installer set 9026252

(8) Component handling cart 9026253-11 from engine components installer set 9026252

(9) Extension bar SX-24 from engine components installer set 9026252

(10) Universal joint S8 from engine components installer set 9026252

(11) Single-Head Special Tool Kit G3127

(12) Torque wrench capable of torquing to 12-110 in-lb

(13) Pin puller CJ-92 (Snap-On-Tool Co), or equivalent

(14) Torque wrench adapter T-5040045

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track (section V) around engine. Install turntable with controls leading.

d. Remove oxidizer inlet duct (paragraph 3-222).

NOTE

It is not necessary to remove the oxidizer inlet duct from the stage.

- Figure 3-52 illustrates the parts removed in steps dA, dB, and dC.

dA. Remove oxidizer bleed line flange bolts and washers at oxidizer bleed valve and remove seal. Leave small brackets attached to line and harness.

dB. Remove screw, washer, nut, and clamp at standoff bracket.

dC. Remove screw, washer, spacer, nut, and clamp at oxidizer turbopump support.

e. Install handler 9026977 and adapter 9026997 on oxidizer turbopump volute as follows:

(1) Install handler with arrow pointing toward oxidizer turbopump engine attach fitting. Place lifting eye in oxidizer turbopump lifting position.

(2) Using torque wrench adapter, cross-torque handler attach bolts to 90-110 in-lb.

(3) Remove screws that attach closure RX20714 on handler. Remove closure.

(4) Place adapter on closure, and install closure and adapter on handler 9026977. Torque bolts to 50-70 in-lb.

f. Remove PU valve (paragraph 3-254) or MRCV (paragraph 3-195B).

g. Remove bolts and washers that secure oxidizer high-pressure duct to oxidizer turbopump only. Remove brackets and seal, and protect open ports and sealing surfaces.

h. Disconnect electrical connectors (paragraph 3-30) P113, P127, and P162. (See figure 3-58.)

i. Cut the following lines (items 7 and 8 not applicable to engines J-2087 and J-2120 unless MD282 change is incorporated): (See figure 3-58. Refer to section VI for tube cutting requirements. Cut lines on downstream (engine) side of straight line downstream of first bend; then protect open ends of cut lines.)

(1) Primary seal drain line (PSD)

(2) Intermediate seal purge line (ISP)

(3) Instrumentation line (PO7)

(4) Turbine seal drain line (TSD)

(5) Instrumentation line (PO6)

(6) Turbine seal purge line (TSP)

(7) Redundant instrumentation line (TF1) (removal of section required)

(8) Redundant instrumentation line (NN1) (removal of section required)

j. Cut oxidizer turbine inlet pressure line (TG3). (Refer to section VI for tube cutting requirements.) Protect open ends of cut lines.

k. On engines incorporating MD302 or MD323 change, cut oxidizer pump drain customer connect line. (Refer to section VI for tube cutting requirements.) Protect open ends of cut line.

l. Remove bolts, washers, and nuts that secure fuel turbine exhaust duct to oxidizer turbopump. Remove brackets and seal. Protect openings and sealing surfaces.

m. Install handler 9016790-11 on heat exchanger with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine.

n. Remove bolts and washers that secure bracket to oxidizer pump torque access plate.

o. Remove bolts and washers that secure heat exchanger to oxidizer turbopump.

p. Compress heat exchanger bellows by turning handknobs on heat exchanger handler. Remove seal at turbopump exhaust flange. Protect openings and sealing surfaces.

q. Install hook on hoist in position shown in figure 3-6, view A.

r. Install pickup adapter on hook, and secure hook latch with ball-lock pin.

s. Connect hoist to handler eyebolt, secure with ball-lock pin, and support weight of turbopump (304 pounds).

t. Remove bolts and washers that secure bipod fitting to oxidizer turbopump and move bipod fitting away from turbopump. (See figure 3-58.) It may be necessary to rotate bipod fitting to extract it from turbopump.

u. Remove cotter pin and, using pin puller CJ-93, remove pin that secures oxidizer turbopump to upper bipod mount. (See figure 3-58, detail B.)

v. Move turbopump away from thrust chamber until turbopump center mount fitting is disengaged from bearing on thrust chamber. If fitting cannot be disengaged from thrust chamber, remove 4 bolts that secure fitting to turbopump; then remove turbopump and fittings from engine. (See figure 3-58, detail A.)

w. Remove protective material from turbopump and engine ports; install clean protective closures (paragraph 3-258) on all open ports.

x. Assemble hanger in accessible area near stage access door.

y. Using hoist, move turbopump to hanger.

CAUTION

Raising the hoist boom above the indicated maximum height can damage equipment.

z. Raise hoist until pickup adapter engages hanger shackle. Do not raise hoist above indicated maximum height. If pickup adapter does not engage hanger shackle with hoist adjusted to maximum, adjust boom turnbuckle until pickup adapter engages hanger shackle.

aa. Remove ball-lock pin from hook, and remove hoist from hanger.

ab. Assemble elevated track (section V) for removal of oxidizer turbopump from stage.

ac. Install chain-hoist on hoist and secure with ball-lock pin.

ad. Loosen internal wrenching bolt, and remove hook from chain hoist.

ae. Move hoist into position to pick up turbopump.

af. Make sure lifting adapter on turbopump adapter 9026997 is installed directly above the centerline chain LOX turbopump position.

ag. Connect chain-hoist chain to lifting adapter, and torque internal wrenching bolt to 12-15 in-lb.

ah. Using hoist and chain-hoist, remove turbopump from hanger.

CAUTION

The turbopump must be restrained due to the limited access, to prevent damage to the turbopump and stage.

ai. Using hoist, move turbopump through stage access door. Manually restrain movement of turbopump when moving it through stage access door.

aj. Using chain-hoist and hoist, lower turbopump to component handling cart.

ak. Install turbopump in cart, and remove chain hoist from handler.

3-240. INSTALLING OXIDIZER TURBOPUMP (ENGINE HANDLER OR UNSTACKED STAGE). The oxidizer turbopump (figure 3-58) may be removed and reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

CAUTION

Care must be taken when the oxidizer turbopump is installed on engines incorporating MD251 or MD252 change, to prevent damage to insulation.

a. If engine is in an unstacked stage, obtain suitable handling equipment to support and lift turbopump (304 pounds), and obtain pin puller CJ-93 (Snap-On-Tool Co).

b. If engine is in handler, obtain the following equipment:

(1) Turbopump Sling G4046 (used when engine is installed in handler) or Turbopump Rotating Sling G4063 (used when turbopump is to be rotated from horizontal to vertical position after removal)

(2) Oxidizer pump inlet flange adapter RX19142-11 (used when engine is installed in handler)

(3) Oxidizer pump discharge flange adapter RX19141-11 (used when engine is installed in handler)

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove protective closures (paragraph 3-257). Make sure that oxidizer pump, mating connections on oxidizer turbopump and engine, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

e. Install adapters RX19142 and RX19141 on oxidizer inlet and turbine exhaust flanges respectively (figure 3-58). Adapter on inlet is to be installed with indexing holes in adapter and inlet flange alined. Adapter on exhaust flange is to be installed with lifting lug on adapter adjacent to seal monitor port on turbine exhaust flange and alined with lifting lugs on inlet adapter. Torque bolts securing adapters to 25-30 in-lb.

f. Install Turbopump Sling G4046 or Turbopump Rotating Sling G4063 on adapters. (See figure 3-22 when using G4063.) Attach hoist capable of lifting 350 pounds to sling.

g. Remove oxidizer turbopump from Oxidizer Turbopump Maintenance Stand G4062.

WARNING

The following specifies primer (MIL-P-8585), which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

h. If fitting on turbopump center mount (see figure 3-58, detail A) was removed, apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, attach fitting to turbopump with bolts and washers. Torque bolts to 223-247 in-lb and safetywire.

i. Position turbopump on thrust chamber and insert turbopump center mount into swivel bearing on thrust chamber.

j. Install pin that secures oxidizer turbopump to upper bipod mount and secure with cotter pin.

k. Apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, attach lower bipod fitting (figure 3-58) to turbopump with bolts and washers. Torque bolts to 223-247 in-lb and safetywire.

l. Remove hoist and sling from oxidizer turbopump.

m. Remove protective material and install seal between turbopump flange and fuel turbine exhaust duct flange. Secure flanges with bolts, washers, brackets, and nuts. Cross-torque bolts to 119-131 in-lb.

n. Make sure oxidizer turbine inlet pressure line adapter is torqued to 67-73 in-lb. If there is an indication of slippage, remove adapter, replace seal, reinstall adapter, and torque to 67-73 in-lb.

o. On engines incorporating MD302 or MD323 change, weld oxidizer pump drain customer connect line. (Refer to section VI for tube welding requirements.)

oA. Obtain new orifice sleeve RD273-1026-XXXX, to be installed in turbine seal purge line (TSP). Orifice sleeve size should be within 0.002 inch of removed orifice.

oB. Identify each end of orifice sleeve since flow characteristics may vary from end to end.

oC. Flow-test new orifice sleeve as follows.

(1) Using 2 one-inch lengths of Tygon tubing and hose clamps, secure orifice sleeve in turbine seal purge line. Position tubing and clamps to prevent leakage between line and sleeve.

(2) Remove protective closures from the following:

(a) Oxidizer turbine seal drain line

(b) Fuel turbine seal drain line

(c) Thrust chamber exit, or open one desiccant access opening on cover.

(3) Remove plug and seal from fitting between fuel turbopump and fuel turbopump drain check valve.

(4) On engines incorporating MD234 change, remove bolts and washers that secure drain line to STDV, and remove seal. Install test plate 9025399 between drain line flange and STDV drain line boss. Torque bolts to 42-45 in-lb.

(5) Install test plate 9020222-11 on PURGE MANIFOLD SYSTEM customer connect. Torque nuts to 61-75 in-lb.

(6) Install a tee fitting on test plate 9020222-11 installed on PURGE MANIFOLD SYSTEM customer connect.

(7) Connect pneumatic system (helium) capable of supplying 68 ±1 psig to tee on test plate 9020222-11.

(8) Connect a monitor system capable of measuring 68 ±1 psig to tee on test plate 9020222-11.

(9) Install exhaust system test plates as outlined in R-3825-1B.

(10) Remove cap from adapter 9022823 installed on torque access of fuel turbine exhaust duct.

(11) Adjust pressure to test plate 9020222-11 until monitor gage indicates 68 ±1 psi.

(12) Using pneumatic flowtester with accumulator, measure and record flow at each of the following points: (Total flowrates recorded in this step must not exceed 10,368 scim.)

(a) Oxidizer turbine seal drain. Record actual value as oxidizer turbine seal purge flow. Minimum allowable flow is 2,400 scim.

(b) Fuel turbine seal drain. Record actual value as fuel turbine seal purge flow. Minimum allowable flow is 2,400 scim.

(c) Fitting between fuel turbopump and fuel turbopump drain check valve. Record actual value as fuel turbopump primary seal purge flow. Minimum allowable flow is 200 scim.

(d) Fitting of test adapter 9022823 installed on torque access of fuel turbopump turbine exhaust duct. Record actual flow as GG fuel purge flow. Minimum allowable flow is 2,400 scim.

(13) Reduce pneumatic pressure until monitor gage indicates zero.

(14) If results in substep 12 are not acceptable, replace orifice sleeve or reverse orifice sleeve being tested end for end and repeat substeps 11 through 13 until required flow is obtained. If flow requirements cannot be met with available orifice sleeves, drilling orifice to larger diameter to meet requirements is permissible. If orifice is enlarged, debur as required.

(15) Remove hose clamps, Tygon tubing, and orifice from turbine seal purge line.

(16) If orifice required enlarging, reidentify (orifice size) using same method as existing part number. (Last four digits of part number designate orifice size.)

(17) Clean acceptable orifice sleeve for pneumatic service (section I).

(18) Disconnect pneumatic supply from tee on test plate 9020222-11.

(19) Install plug and seal in fitting between fuel turbopump and fuel turbopump drain check valve. Torque to 65-70 in-lb and safetywire.

(20) Test plates installed for flow test may be removed or retained in-place for oxidizer turbopump post-installation testing.

p. Weld the following lines (items 8 and 9 not applicable to engines J-2087 and J-2120 unless MD282 change is incorporated): (See figure 3-58. Refer to section VI for tube welding requirements.)

(1) Oxidizer turbine inlet pressure line (TG3)

(2) Turbine seal purge line (TSP). (Make sure sleeve orifice is installed in line in same direction as flow-tested.)

(3) Instrumentation line (PO6)

(4) Turbine seal drain line (TSD)

(5) Instrumentation line (PO7)

(6) Intermediate seal purge line (ISP)

(7) Primary seal drain line (PSD)

(8) Redundant instrumentation line (TF1)

(9) Redundant instrumentation line (NN1)

pA. Fabricate a metal tag with nomenclature "ORIFICE SLEEVE" and part number of orifice sleeve, and install tag on turbine seal purge line (TSP) using lockwire. Make sure old tag has been removed.

q. Connect electrical connectors (paragraph 3-31) P113, P127, and P162.

r. Remove protective material from mating flanges between oxidizer turbopump and oxidizer high-pressure duct, install seal, position bracket and spacers on flange, and install bolts and washers that secure duct to turbopump. Cross-torque bolts to 361-399 in-lb and safetywire.

rA. Remove handling adapters from oxidizer turbopump.

s. Install heat exchanger (paragraph 3-124).

t. On engines not incorporating MD105 and MD194 change, remove protective material from mating flanges of heat exchanger and antiflood check valve and install seal and antiflood check valve on heat exchanger with washers and bolts. Using adapter T-5044632, cross-torque bolts to 95-105 in-lb and safetywire.

u. On engines incorporating MD105 and MD194 change, remove protective material from mating flanges of heat exchanger oxidizer inlet line and heat exchanger. Install seal, oxidizer inlet line, and support on heat exchanger with bolt and washers. Cross-torque bolts to 95-105 in-lb and safetywire.

v. On engines incorporating MD105 and MD194 change, remove protective material from mating flanges of heat exchanger bypass line and support. Install seal and bypass line on support with bolts, washers, and nuts. Cross-torque bolts to 57-68 in-lb.

NOTE

Figure 3-52 illustrates the parts installed in steps vA, vB, and vC.

vA. Remove protective material from oxidizer bleed line and oxidizer bleed valve mating flanges. Position oxidizer bleed line on engine, and install seal, bolts, washers, and brackets on oxidizer bleed valve and oxidizer bleed line flange. Torque bolts to 30-40 in-lb and safetywire.

vB. Install clamp, screw, washers, spacer, and nut on oxidizer bleed line at oxidizer turbopump support. Torque screw to 30-40 in-lb.

vC. Install clamp, screw, washer, and nut at standoff bracket. Torque screw to 24-30 in-lb.

w. Install PU valve (paragraph 3-255) or MRCV (paragraph 3-195C).

x. Install oxidizer inlet duct on engine installed in handler (paragraph 3-223) and on engines in an unstacked stage (paragraph 3-224).

y. On engines incorporating MD251 or MD252 change, make sure insulation is installed (paragraph 3-157).

z. Refer to section IV for test requirements.

3-241. INSTALLING OXIDIZER TURBOPUMP (STACKED SII STAGE). The oxidizer turbopump (figure 3-58) may be removed and reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

CAUTION

Care must be taken when the oxidizer turbopump is installed on engines incorporating MD251 or MD252 change, to prevent damage to insulation.

a. Obtain the following equipment: (Items 9 through 14 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4071, shelf 3

(2) Automatic Inert Gas Arc Welding Set G3128

(3) Single-Head Special Tool Kit G3127

(4) Hook 9024600 from Engine Components Installer G4071, shelf 1

(5) Torque wrench capable of torquing to 12-110 in-lb

(6) Torque wrench capable of torquing to 223-525 in-lb

(7) Oxidizer heat exchanger handler 9016790-11

(8) Torque wrench adapter T-5040045

(9) Pickup adapter 9024547 from engine components installer set 9026251

(10) Hanger 9024543 from engine components installer set 9026251

(11) Chain-hoist 9027095 from engine components installer set 9026251

(12) Universal joint S8 from engine components installer set 9026251

(13) Extension bar SX-24 from engine components installer set 9026251

(14) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(15) Component handling cart 9026253-11 from engine components installer set 9026251

(16) Ramps 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(17) Torque wrench adapter T-5044632

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure that oxidizer turbopump, mating connections on oxidizer turbopump and engine, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Install handler 9026977 on oxidizer turbopump volute with arrow pointing toward oxidizer turbopump engine attach fitting. Using torque wrench adapter T-5040045, cross-torque handler attach bolts to 90-110 in-lb. Install closure RX20714 on handler.

NOTE

If the launch tower umbilical arm is used for transporting the components to the stage, omit steps e through l; otherwise, omit steps m through o.

e. Install pickup adapter 9024547 on handler.

f. Position hoist on track near stage access door and install chain-hoist 9027095 on hoist boom.

g. Move hoist boom through stage access door and lower hoist hook and attach to pickup adapter, using shackle.

h. Slowly raise turbopump (304 pounds) and transfer turbopump through stage access door.

i. Move turbopump to hanger and attach turbopump to hanger, using pickup adapter swivel; secure with ball-lock pin.

j. Remove chain-hoist 9027095 from hoist boom.

k. Install hook 9024600 on hoist boom as shown in figure 3-6, view A.

l. Connect hook on hoist boom to pickup adapter 9024547 and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

m. Install hook 9024600 on hoist boom as shown in figure 3-6, view A.

n. Connect hook on hoist boom to handler lifting eye on turbopump and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

o. Slowly raise turbopump and transfer turbopump through stage access door.

p. Position hoist at track station 15. 5 for engine positions 1 through 4, or track station 16 for engine position 5.

q. Install handler 9016790-11 on heat exchanger, with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine.

r. Compress heat exchanger bellows by turning handknob on heat exchanger duct handler.

WARNING

The following specifies primer (MIL-P-8585), which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

s. If fitting on turbopump center mount (see figure 3-58, detail A) was removed, apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, attach fitting to turbopump with bolts and washers. Torque bolts to 223-247 in-lb and safetywire.

t. Using hoist, position turbopump on thrust chamber and insert turbopump center mount into swivel bearing on thrust chamber.

u. Install pin that secures oxidizer turbopump to upper bipod mount and secure with cotter pin.

v. Apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, attach lower bipod fitting (figure 3-58) to turbopump with bolts and washers. Torque bolts to 223-247 in-lb and safetywire.

w. Remove handler from oxidizer turbopump.

x. Disassemble track (section V).

y. Remove protective material and install seal between heat exchanger and turbopump exhaust flange.

z. Loosen handknobs on heat exchanger handler, and secure duct to turbopump with bolts, nuts, and washers. Tighten nuts fingertight.

aa. Remove heat exchanger handler 9016790-11 from heat exchanger.

ab. Install bracket on oxidizer pump torque access plate and secure with bolts, nuts, and washers. Install bolts fingertight.

ac. Cross-torque nuts at turbopump flange to 76-84 in-lb and safetywire. Torque the 3 bolts that secure bracket to access plate to 40-50 in-lb and safetywire.

ad. Remove protective material and install seal between turbopump flange and fuel turbine exhaust duct flange. Secure flanges with bolts, washers, brackets, and nuts. Torque bolts to 119-131 in-lb.

ae. Make sure adapter for oxidizer turbine inlet pressure line is torqued to 67-73 in-lb. If slippage is indicated, remove adapter, replace seal, reinstall adapter, and torque to 67-73 in-lb.

af. Weld the following lines (items 8 and 9 not applicable to engines J-2087 and J-2120 unless MD282 change is incorporated): (See figure 3-58. Refer to section VI for tube welding requirements.)

(1) Oxidizer turbine inlet pressure line (TG3)

(2) Turbine seal purge line (TSP). (Make sure sleeve orifice is installed in line near support bracket.)

(3) Instrumentation line (PO6)

(4) Turbine seal drain line (TSD)

(5) Instrumentation line (PO7)

(6) Intermediate seal purge line (ISP)

(7) Primary seal drain line (PSD)

(8) Redundant instrumentation line (TF1)

(9) Redundant instrumentation line (NN1)

ag. Connect electrical connectors (paragraph 3-31) P113, P127, and P162.

ah. Remove protective material from mating flanges between oxidizer turbopump and oxidizer high-pressure duct, install seal, position bracket and spacers on flange, and install bolts and washers that secure duct to turbopump. Cross-torque bolts to 361-399 in-lb and safetywire.

NOTE

Figure 3-52 illustrates the parts installed in steps ahA, ahB, and ahC.

ahA. Remove protective material from oxidizer bleed line and oxidizer bleed valve mating flanges. Position oxidizer bleed line on engine, and install seal, bolts, washers, and brackets on oxidizer bleed valve and oxidizer bleed line flange. Torque bolts to 30-40 in-lb and safetywire.

ahB. Install clamp, screw, washers, spacer, and nut on oxidizer bleed line at oxidizer turbopump support. Torque screw to 30-40 in-lb.

ahC. Install clamp, screw, washer, and nut at standoff bracket. Torque screw to 24-30 in-lb.

ai. Install PU valve (paragraph 3-255) or MRCV (paragraph 3-195C).

aj. Install oxidizer inlet duct for engine positions 1 through 4 (paragraph 3-225), and for engine position 5 in accordance with applicable Stage Contractor procedures.

ak. On engines incorporating MD251 or MD252 change, make sure insulation is installed (paragraph 3-157).

al. Refer to section IV for test requirements.

3-242. INSTALLING OXIDIZER TURBOPUMP (STACKED SIVB STAGE). The oxidizer turbopump (figure 3-58) may be removed and reinstalled but not replaced without affecting engine calibration.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment:

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4072, shelf 3

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

(3) Pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Adapter 9026997 from engine components installer set 9026252

(6) Chain-hoist 9027095 from engine components installer set 9026252

(7) Component handler cart 9026253-11 from engine components installer set 9026252

(8) Universal joint S8 from engine components installer set 9026252

(9) Extension bar SX-24 from engine components installer set 9026252

(10) Oxidizer heat exchanger handler 9016790-11

(11) Automatic Inert Gas Arc Welding Set G3128

(12) Single-Head Special Tool Kit G3127

(13) Torque wrench capable of torquing to 12-110 in-lb

(14) Torque wrench capable of torquing to 223-525 in-lb

(15) Torque wrench adapter T-5040045

(16) Torque wrench adapter T-5044632

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure that oxidizer turbopump, mating connections on oxidizer turbopump and engine, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Install handler 9026977 and adapter on oxidizer turbopump volute as follows:

(1) Remove closure, and install handler with arrow pointing toward oxidizer turbopump engine attach fitting. Place lifting eye in oxidizer turbopump lifting position.

(2) Using torque wrench adapter T-5040045, cross-torque handler attach bolts to 90-110 in-lb.

(3) Remove screws that attach closure to handler. Remove closure.

(4) Place adapter on closure and install closure and adapter on handler. Cross torque bolts to 50-70 in-lb.

(5) Make sure lifting adapter on turbopump adapter is directly above centerline chain LOX turbopump position. Remove ball-lock pin and rotate adapter, if required.

e. Install chain-hoist on hoist and secure with ball-lock pin.

f. Connect chain-hoist chain fitting to lifting adapter, and torque internal wrenching bolt (on chain fitting) to 12-15 in-lb.

g. Using chain-hoist and hoist, raise oxidizer turbopump (304 pounds) from cart.

CAUTION

The turbopump must be restrained due to the limited access, to prevent damage to the turbopump and stage.

h. Using hoist, move oxidizer turbopump into stage. Manually restrain movement of oxidizer turbopump when moving it through stage access door.

i. Make sure pickup adapter is attached to hanger.

j. Using hoist, move oxidizer turbopump to hanger, and lower chain-hoist and/or hoist until handler lifting eye engages pickup adapter.

k. Secure oxidizer turbopump to hanger with ball-lock pin on pickup adapter.

l. Remove hoist and chain-hoist. Install chain-hoist hook on chain-hoist, and torque internal wrenching bolt to 12-15 in-lb.

m. Disassemble elevated track, and reassemble lower track. (Refer to section V.)

n. Install hook on hoist. (See figure 3-6, view A.)

o. Position hoist and connect hook to pickup adapter and secure hook latch with ball-lock pin.

CAUTION

Raising the hoist boom above the indicated maximum height can damage the equipment.

p. Raise hoist and remove fuel turbopump from hanger. Do not raise hoist above indicated maximum height. Adjust boom turnbuckle to obtain additional hoist height.

q. Using hoist, move oxidizer turbopump to engine.

r. Install handler 9016790-11 on heat exchanger, with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine.

s. Compress heat exchanger bellows by turning handknob on heat exchanger duct handler.

WARNING

The following specifies primer (MIL-P-8585), which is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the primer can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

t. If fitting on turbopump center mount was removed, apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, attach fitting to turbopump with bolts and washers. Torque bolts to 223-247 in-lb and safetywire.

u. Using hoist, position turbopump on thrust chamber and insert turbopump center mount into swivel bearing on thrust chamber.

v. Install pin that secures oxidizer turbopump to upper bipod mount and secure with cotter pin.

w. Apply one coat of zinc chromate primer (MIL-P-8585) to turbopump mounting pad. While primer is still wet, attach lower bipod fitting (figure 3-58) to turbopump with bolts and washers. Torque bolts to 223-247 in-lb and safetywire.

x. Remove handler from oxidizer turbopump.

y. Disassemble track (section V).

z. Remove protective material and install seal between heat exchanger and turbopump exhaust flange.

aa. Loosen handknobs on heat exchanger handler and secure duct to turbopump with bolts, nuts, and washers. Tighten nuts fingertight.

ab. Remove heat exchanger handler 9016790-11 from heat exchanger.

ac. Install bracket on oxidizer pump torque access plate and secure with bolts, nuts, and washers. Install bolts fingertight.

ad. Cross-torque nuts at turbopump flange to 76-84 in-lb and safetywire. Torque the 3 bolts that secure bracket to access plate to 40-50 in-lb and safetywire.

ae. Remove protective material and install seal between turbopump flange and fuel turbine exhaust duct flange. Secure flanges with bolts, washers, brackets, and nuts. Torque bolts to 119-131 in-lb.

af. Make sure adapter for oxidizer turbine inlet pressure line is torqued to 67-73 in-lb. If slippage is indicated, remove adapter, reinstall adapter, and torque to 67-73 in-lb.

ag. Weld the following lines (items 8 and 9 not applicable to engines J-2087 and J-2120 unless MD282 change is incorporated): (See figure 3-58. Refer to section VI for tube welding requirements.)

(1) Oxidizer turbine inlet pressure line (TG3)

(2) Turbine seal purge line (TSP). Make sure sleeve orifice is installed in line near support bracket.)

(3) Instrumentation line (PO6)

(4) Turbine seal drain line (TSD)

(5) Instrumentation line (PO7)

(6) Intermediate seal purge line (ISP)

(7) Primary seal drain line (PSD)

(8) Redundant instrumentation line (TF1)

(9) Redundant instrumentation line (NN1)

agA. On engines incorporating MD302 or MD323 change, weld oxidizer pump drain customer connect line. (Refer to section VI for tube welding requirements.)

ah. Connect electrical connectors (paragraph 3-31) P113, P127, and P162.

ai. Remove protective material from mating flanges between oxidizer turbopump and oxidizer high-pressure duct, install seal, position bracket and spacers on flange, and install bolts and washers that secure duct to turbopump. Cross-torque bolts to 361-399 in-lb and safetywire.

NOTE

Figure 3-52 illustrates the parts installed in steps aiA, aiB, and aiC.

aiA. Remove protective material from oxidizer bleed line and oxidizer bleed valve mating flanges. Position oxidizer bleed line on engine, and install seal, bolts, washers, and brackets on oxidizer bleed valve and oxidizer bleed line flange. Torque bolts to 30-40 in-lb and safetywire.

aiB. Install clamp, screw, washers, spacer, and nut on oxidizer bleed line at oxidizer turbopump support. Torque screw to 30-40 in-lb.

aiC. Install clamp, screw, washer, and nut at standoff bracket. Torque screw to 24-30 in-lb.

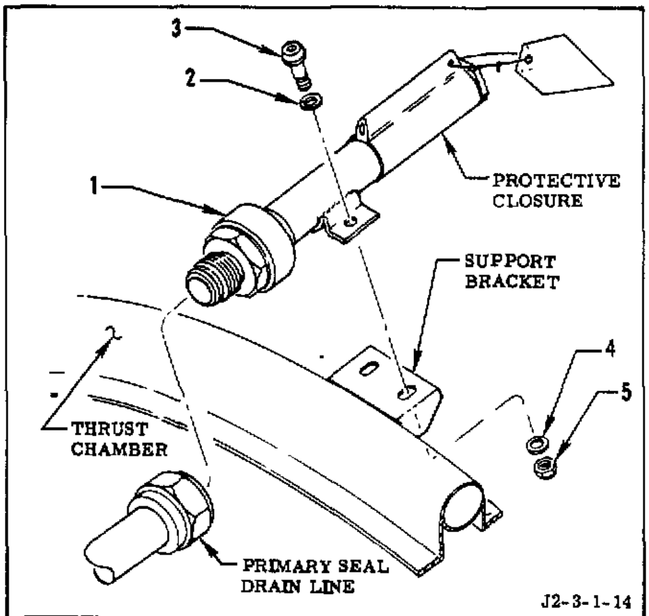
aj. Install PU valve (paragraph 3-255) or MRCV (paragraph 3-195C).

ak. Install oxidizer inlet duct (paragraph 3-226).

al. Refer to section IV for test requirements.

3-243. OXIDIZER TURBOPUMP PRIMARY SEAL DRAIN LINE BURST DIAPHRAGM.

3-244. REMOVING OXIDIZER TURBOPUMP PRIMARY SEAL DRAIN LINE BURST DIAPHRAGM. (See figure 3-59.)



Index No.	Description
1	Drain line burst diaphragm
2	Washer
3	Bolt
4	Washer
5	Nut

Figure 3-59. Oxidizer Turbopump Primary Seal Drain Line Burst Diaphragm

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Using applicable wrenches, hold union hex securely and disconnect drain line burst diaphragm (1).

c. Remove nuts (5), washers (4), bolts (3), and washers (2). Then remove drain line burst diaphragm (1). When removing primary seal drain line burst diaphragm, do not remove closure from drain line unless desiccant and/or closure must be replaced.

d. Install clean protective closures (paragraph 3-258) on drain line burst diaphragm and primary seal drain line.

3-245. INSTALLING OXIDIZER TURBOPUMP PRIMARY SEAL DRAIN LINE BURST DIAPHRAGM. (See figure 3-59.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257) from drain line burst diaphragm and primary seal drain line. Make sure burst diaphragm, drain line, and threads are clean and free of damage.

CAUTION

Touching or handling the diaphragm may result in damage to the coined surface.

c. Lubricate (Method A, section I) male threads of drain line burst diaphragm (1) with lubricant grease RB0140-012 (Rocketdyne).

d. Aline holes in drain line burst diaphragm bracket with holes in thrust chamber bracket and install washers (2), bolts (3), washers (4), and nuts (5). Tighten nuts fingertight.

e. Connect drain line burst diaphragm (1) to B-nut. Restrain burst diaphragm with wrench on hex adjacent to B-nut, make sure torque will not be applied to burst diaphragm, and torque B-nut to 290-300 in-lb.

f. Torque bolts (3) to 24-30 in-lb.

g. Make sure clean protective closure (paragraph 3-258) is installed on drain line burst diaphragm.

3-245A. <u>PRESSURIZING VALVES (SPARK IGNITER CABLE, ELECTRICAL CONTROL ASSEMBLY, AUXILIARY AND PRIMARY FLIGHT INSTRUMENTATION PACKAGES).</u>

3-245B. REMOVING PRESSURIZING VALVE.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

On ECA and auxiliary and primary FI packages, if the 5/8-inch swivel nut is loosened too much, the valve stem may drop into the component in which the valve is installed.

aA. Depressurize SIC, ECA, auxiliary FI package, or primary FI package by loosening pressurizing valve swivel nut (using crowfoot wrench 9019552 from tool kit 9025425-21) one to two full turns and depressing valve core.

b. Using a wrench on 3/4-inch hex portion of pressurizing valve, remove valve and packing. When removing valve from SIC, hold valve boss to prevent boss from rotating.

c. Lubricate (Method A, section I) plug AN814-5 and (Method J, section I) packing MS28775-014 with lubricant grease RB0140-012 (Rocketdyne). Install plug in component port or boss. Torque plug to 60-80 in-lb. If plug is being installed in SIC pressurizing boss, hold pressurizing boss to prevent rotation during torquing.

3-245C. INSTALLING PRESSURIZING VALVE.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove plug AN814-5 and packing MS28775-014 from port or boss.

c. Make sure packing groove in pressurizing valve, and port or boss are clean and free of damage, and threads of valve, threads in parent metal, and/or threaded insert are free of dama age and installed coreectly (section I).

d. Lubricate (Method J, section I) pressurizing valve packing with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne) and install on valve.

e. Lubricate (Method A, section I) exterior threads of pressurizing valve (SIC installations only) with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Do not lubricate pressurizing valves used on ECA and FI package installation.

CAUTION

Applying torque to pressurizing valve 5/8-inch swivel nut hex can damage the valve.

f. Install pressurizing valve in component port or boss. Torque valve 3/4-inch hex nut to 200 ±10 in-lb. If valve is being installed in SIC pressurizing boss, hold pressurizing boss to prevent rotation during torquing.

g. After a minimum of 30 minutes, retorque valve to 200 ±10 in-lb and safetywire.

h. Install valve cap on pressurizing valve. Torque cap to 20-25 in-lb.

i. Refer to section IV for test requirements.

3-246. PRIMARY FLIGHT INSTRUMENTATION PACKAGE.

3-247. REMOVING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (ENGINE HANDLER OR UNSTACKED STAGE). This procedure is for manual removal of the primary FI package. (See figure 3-60.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove support clamps as required to gain access for removal of primary FI package. Note location and position of clamps for reinstallation.

c. Disconnect and secure electrical connectors (paragraph 3-30) P100, P101, P102 (on engines not incorporating MD233 change), P103, and P104.

d. Remove bolts and washers that secure accumulator hose and filter to instrumentation package; and remove hose, filter, and seals. Protect open flange of hose and open port in instrumentation package.

e. Cut instrumentation lines to primary FI package, and protect open lines. (Refer to section VI for tube cutting requirements.)

f. Remove bolts and washers that secure bonding wire to clevis.

g. Support primary FI package (approximately 32 pounds). Note position of spacers, bracket, and washer for reinstallation and remove bolts, washers, spacers, bracket, and nut that secure package to strut and clevises.

h. Remove package, and install clean protective closures (paragraph 3-258) on all open ports.

i. If it is expected that more than 7 days will elapse before reinstallation, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas on primary FI package where protective finish has been removed.

j. If primary FI package is to be replaced, note any difference in quantity of redundant seals on transducers between removed and replacement packages. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

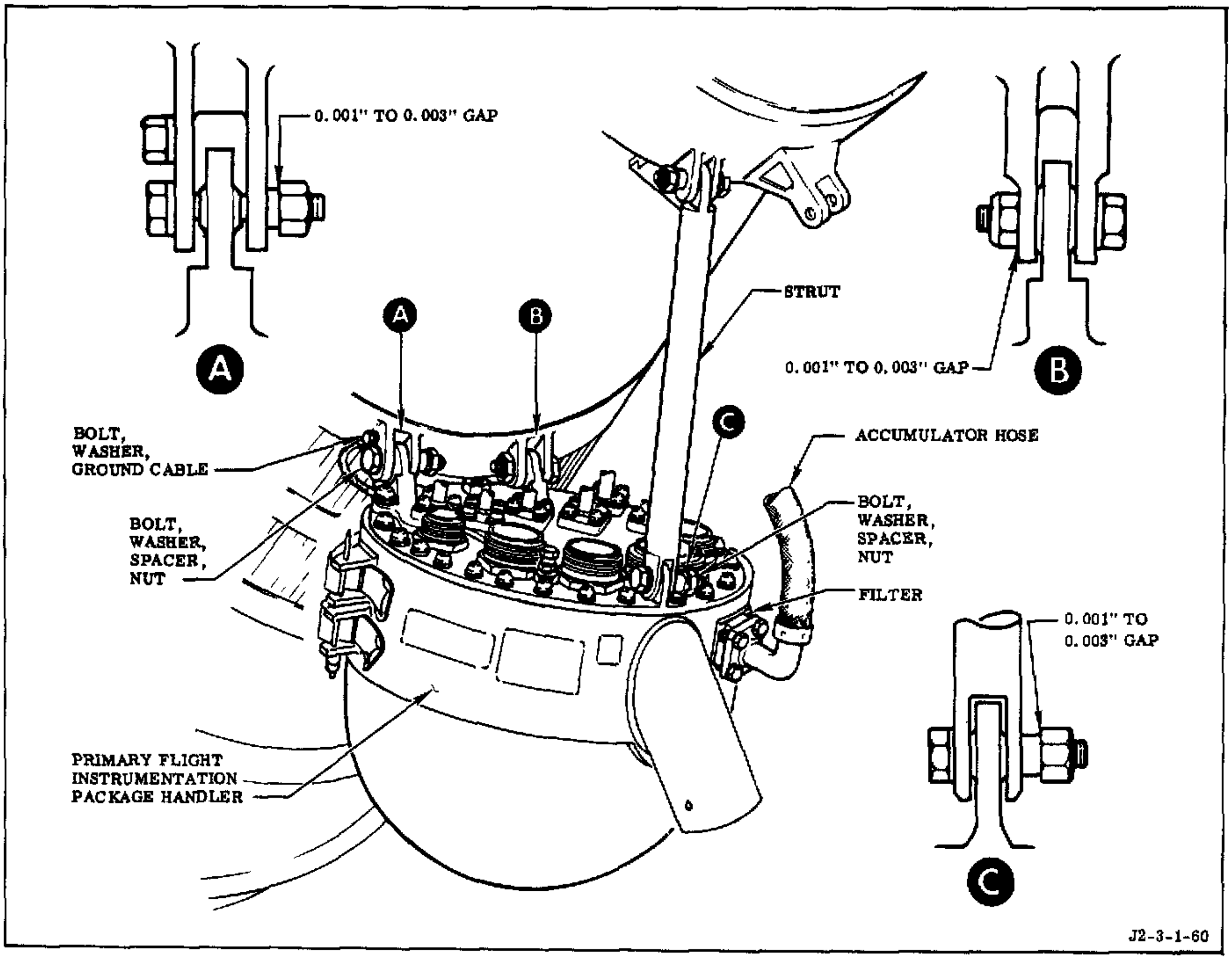


Figure 3-60. Primary Flight Instrumentation Package

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

3-248. REMOVING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (STACKED SII STAGE). This procedure removes the primary FI package (figure 3-60) using specialized handling equipment for stacked stages. However, since the weight of the primary FI package (approximately 32 pounds) does not require the use of this equipment, the primary FI package may be removed manually (paragraph 3-247).

a. Obtain the following equipment and material: (Item 4 is required only if launch tower umbilical arm is to be used for transporting component from stage.)

(1) Primary FI package handler 9026942 from Engine Components Installer G4071

(2) Component handling cart 9026253-11 from engine components installer set 9026251

(3) Component handler universal lifting sling 9016779

(4) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(5) Blue-tinted lacquer ST0125RB0003 (Rocketdyne). Required only if it is expected that more than 7 days will elapse between removal and reinstallation of primary package.

b. Assemble track (section V) around engine from which primary FI package is to be removed.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove support clamps as required to gain access for removal of primary FI package. Note location and position of clamps for reinstallation.

e. Disconnect and secure electrical connectors (paragraph 3-30) P100, P101, P102 (on engines not incorporating MD233 change), P103, and P104.

f. Remove bolts and washers that secure accumulator hose and filter to instrumentation package; and remove hose, filter, and seals. Protect open flange of hose and open port in instrumentation package.

g. Cut instrumentation lines to primary FI package, and protect open lines. (Refer to section VI for tube cutting requirements.)

h. Remove bolts and washers that secure ground cable to clevis.

i. Install handler on primary FI package with cutout engaging accumulator hose connection boss, and secure strap latches with ball-lock pin.

j. Connect hoist to handler and secure connection with ball-lock pin. (See figure 3-6.)

k. Support weight of primary FI package (approximately 32 pounds). Note position of spacers, bracket, and washers for reinstallation, and remove bolts, washers, spacers, bracket, and nut that secure package to strut and clevises.

l. Remove package, and install clean protective closures (paragraph 3-258) on all open ports.

m. If more than 7 days are expected to elapse before reinstallation of primary FI package, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas on primary FI package where protective finish has been removed.

n. If primary FI package is to be replaced, note any difference in quantity of redundant seals between removed and replacement packages. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

o. Using hoist, move primary FI package to an accessible area near stage access door.

p. Remove handler (with primary FI package attached) from hoist and temporarily place on protective pad.

q. Install component handler universal lifting sling on handler and secure with ball-lock pin. (The combined weight of primary FI package, sling, and handler is approximately 40 pounds.)

r. Using lifting eye on sling, manually transport primary FI package through stage access door and place package in component handling cart.

3-249. REMOVING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (STACKED SIVB STAGE). This procedure removes the FI package (figure 3-60) using specialized handling equipment for stacked stages. However, since the weight of the primary FI package (approximately 32 pounds) does not require the use of this equipment, the primary FI package may be removed manually (paragraph 3-247).

a. Obtain the following equipment and materials: (Item 6 is required only if launch tower umbilical arm is used to transport component from vehicle.)

(1) Primary FI package handler 9027225 from Engine Components Installer G4072

(2) Extension 9027080 from Engine Components Installer G4072

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072

(4) Component handler universal lifting sling 9016779

(5) Component handling cart 9026253-11 from engine components installer set 9026252

(6) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026252 (required for use on launch tower umbilical arm)

(7) Blue-tinted lacquer ST0125RB0003 (Rocketdyne). Required only if it is expected that more than 7 days will elapse between removal and reinstallation of primary FI package.

b. Assemble track (section V) for primary FI package removal. Direction of turntable controls is optional.

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

d. Remove support clamps as required to gain access for removal of primary FI package. Note location and position of clamps for reinstallation.

e. Disconnect and secure electrical connectors (paragraph 3-30) P100, P101, P102 (on engines not incorporating MD233 change), P103, and P104.

f. Remove bolts and washers that secure accumulator hose and filter to instrumentation package, and remove hose, filter, and seals. Protect open flange of hose and open port in instrumentation package.

g. Cut instrumentation lines to primary FI package, and protect open lines. (Refer to section VI for tube cutting requirements.)

h. Remove bolts and washers that secure ground cable to clevis.

i. Install sleeve, extension, and handler on hoist. (See figure 3-6, view G.) Position extension in 9th (farthest from extension turnbuckle) positioning hole. Secure with ball-lock pin.

j. Manipulate hoist to lower handler through opening in which lower work platform is installed, and orient handler with primary FI package.

k. Attach handler to primary FI package with cutout engaging accumulator hose connection boss, and secure strap latches with ball-lock pin.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

l. Support primary FI package by manipulation of hoist and turnbuckle on extension. Make sure a minimum of one thread is evident in turnbuckle barrel when turnbuckle is extended. Make sure side load does not exist on primary FI package.

m. Note position of spacers, bracket, and washers for reinstallation, and remove bolts, washers, spacers, bracket, and nuts that secure package to strut and clevises.

n. If it is expected that more than 7 days will elapse before reinstallation of primary FI package, apply blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonding areas on primary FI package where protective finish has been removed.

o. If primary FI package is to be replaced, note any difference in quantity of redundant seals on removed and replacement packages. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

p. Make sure primary FI package is free of engine; then with hoist and extension turnbuckle, move primary FI package clear of engine and through opening in which lower work platform is installed. Extending turnbuckle to its maximum length (one thread evident in adjusting barrel) will effect a narrow profile to aid in raising component through stage work deck.

NOTE

Because of the remoteness of the hoist operator from the primary FI package and deflection of the hoisting equipment, it is recommended that a technician guide the package and otherwise assist the hoist operator.

q. Using hoist, move primary FI package to an accessible area near stage access door.

r. Remove handler (with primary FI package attached) from hoist and temporarily place on protective pad.

s. Install component handler universal lifting sling on handler and secure with ball-lock pin. (The combined weight of package, sling, and handler is approximately 40 pounds.)

t. Using eye on lifting sling, manually transport primary FI package through stage access door and place on component handling cart.

3-250. INSTALLING PRIMARY FLIGHT INSTRUMENTATION PACKAGE. This procedure is for manual installation of the primary FI package. (See figure 3-60.) If the specialized component handling equipment for stacked stages is to be used, refer to paragraph 3-251 or 3-252, as applicable.

a. Obtain a milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent.

b. If component is to be installed on engine in an SIVB stacked stage, install access work platform adjacent to primary FI package. (Refer to section V for access work platform installation procedures.)

c. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

cA. Check pressure in primary FI package. (Refer to R-3825-1B.)

d. If primary FI package has been reworked or is being replaced, note any difference in quantity of redundant seals between removed package and package being installed. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

e. Position primary FI package on engine.

f. Aline package with mounting clevises and strut. Install bolts, spacers, washers, bracket, and nuts. (See figure 3-60.)

g. Tighten nuts until a 0.001 to 0.003 inch gap exists between nut and washer.

h. Using 320-grit (or finer) abrasive cloth or paper, clean contact surfaces of ground cable terminal and its mating surface of all protective finishes and foreign material.

i. Connect ground cable to bracket on thrust chamber bolt and washer. Torque bolt to 27-33 in-lb and safetywire.

j. Using milliohmmeter, measure bonding resistance from primary FI package to thrust chamber. Bonding resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded juncture if excessive resistance is suspected. Complete step k within 24 hours of completion of resistance check; otherwise repeat resistance check.

k. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonded areas.

l. Weld instrumentation lines. (Refer to section VI for welding requirements.) Lines may be welded in any sequence that results in efficient use of weld and purge times.

m. Connect electrical connectors (paragraph 3-31) P100, P101, P102 (on engines not incorporating MD233 change), P103, and P104.

n. Remove protective material and install 2 seals, filter, and accumulator hose with bolts and washers. Install recessed side of filter next to instrumentation package. Torque bolts to 56-62 in-lb and safetywire.

o. If accumulator hose touches electrical cable (electrical cable to P3 connector), apply 2 layers of tape 602 (Moxness Products, Inc) or tape 2650 (Johnson and Johnson, Inc) to electrical cable in area where hose and cable touch.

NOTE

It is permissible for the accumulator hose to touch the taped portion of the electrical cable.

p. Refer to section IV for test requirements.

3-251. INSTALLING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (STACKED SII STAGE). This procedure installs the primary FI package (figure 3-60) using specialized handling equipment for stacked stages. However, since the weight of the primary FI package (approximately 32 pounds) does not require the use of this equipment, the primary FI package may be installed manually (paragraph 3-250).

a. Obtain the following equipment and materials: (Item 4 is required only if launch tower umbilical arm is used to transport component from vehicle.)

(1) Primary FI package handler 9026942 from Engine Components Installer G4071

(2) Component handler universal lifting sling 9016779

(3) Component handling cart 9026253-11 from engine components installer set 9026251

(4) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(5) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

(6) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(7) Tape 602 (Moxness Products, Inc) or tape 2650 (Johnson and Johnson, Inc)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

bA. Check pressure in primary FI package. (Refer to R-3825-1B.)

c. Using component handling cart, transport primary FI package to vehicle.

d. If primary FI package has been reworked or is being replaced, note any difference in quantity of redundant seals between removed package and package being installed. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

e. Install handler on primary FI package in position shown in figure 3-60. Wrap handler straps around primary FI package and secure with ball-lock pin.

f. Attach component handler universal lifting sling to handler and secure with ball-lock pin.

g. Using component handler universal lifting sling as a handle, manually carry primary FI package into stage and lay package on a protective pad on work deck. (The combined weight of the primary FI package, sling, and handler is approximately 40 pounds.)

h. Remove component handler universal lifting sling from handler.

i. Attach handler with primary FI package to hoist. Secure with ball-lock pin.

j. Using hoist, move primary FI package into position on engine.

k. Aline package with mounting clevises and strut. Install bolts, spacers, washers, bracket, and nuts. (See figure 3-60.)

l. Tighten nuts until a 0.001 to 0.003 inch gap exists between nut and adjoining washer.

m. Remove handler from primary FI package.

n. Disassemble track (section V).

o. Using 320-grit (or finer) abrasive cloth or paper, clean contact surfaces of ground cable terminal and its mating surface of all protective finishes and foreign material.

p. Connect ground cable to clevis with bolt and washer. Torque bolt to 27-33 in-lb and safetywire.

q. Using milliohmmeter, measure bonding resistance from primary FI package to thrust chamber. Bonding resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded juncture if excessive resistance is suspected. Complete step r within 24 hours of completion of resistance check; otherwise repeat resistance check.

r. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonded areas.

s. Weld instrumentation lines. (Refer to section VI for welding requirements.) Lines may be welded in any sequence that results in efficient use of weld and purge times.

t. Connect electrical connectors (paragraph 3-31) P100, P101, P102 (on engines not incorporating MD233 change), P103, and P104.

u. Remove protective material and install 2 seals, filter, and accumulator hose with bolts and washers. Install recessed side of filter next to instrumentation package. Torque bolts to 56-62 in-lb and safetywire.

v. If accumulator hose touches electrical cable (electrical cable to P3 connector), apply 2 layers of tape 602 (Moxness Products, Inc) or tape 2650 (Johnson and Johnson, Inc) to electrical cable in area where hose and cable touch.

NOTE

It is permissible for the accumulator hose to touch the taped portion of the electrical cable.

w. Reinstall all line support clamps (section I), and torque screws to 24-30 in-lb.

x. Refer to section IV for test requirements.

3-252. INSTALLING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (STACKED SIVB STAGE). This procedure installs the primary FI package (figure 3-60) using specialized handling equipment for stacked stages. However, since the weight of the primary FI package (approximately 32 pounds) does not require the use of this equipment, the primary FI package may be installed manually. (Refer to paragraph 3-250.)

a. Obtain the following:

(1) Primary FI package handler 9026942 from Engine Components Installer G4072

(2) Extension 9027080 from Engine Components Installer G4072

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072

(4) Component handler universal lifting sling 9016779

(5) Component handling cart 9026253-11 from engine components installer set 9026252

(6) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

(7) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(8) Tape 602 (Moxness Products, Inc) or tape 2650 (Johnson and Johnson, Inc)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

bA. Check pressure in primary FI package. (Refer to R-3825-1B.)

c. Using component handling cart, transport primary FI package to vehicle.

d. If primary FI package has been reworked or is being replaced, note any difference in quantity of redundant seals between removed package and package being installed. Engine weight and balance is affected by the following values for each seal difference: (Values for weight and moment are plus if quantity of seals is increased, minus if quantity of seals is decreased.)

(1) Weight, 0.25 pound

(2) Arm, +37.8 inches

(3) Moment, 9.5 in-lb

NOTE

The effect on the arm due to the physical location of redundant seals is negligible.

- A redundant seal is composed of three metal plates and a seal mounted to the external surface of a transducer.

e. Install handler on auxiliary FI package in position shown in figure 3-60. Wrap handler straps around primary FI package and secure with ball-lock pin.

f. Attach component handler universal lifting sling to handler and secure with ball-lock pin.

g. Using component handler universal lifting sling as a handle, manually carry primary FI package into stage, and lay package on a protective pad on work deck. (The combined weight of the primary FI package, sling, and handler is approximately 40 pounds.)

h. Remove component handler universal lifting sling from handler.

i. Install sleeve and extension on hoist. (See figure 3-6, view G.) Position extension in 9th positioning hole (farthest hole from extension turnbuckle). Secure with ball-lock pin.

j. Attach handler with primary FI package to extension. Secure with ball-lock pin.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

k. Using hoist, lower primary FI package through opening in which lower work platform is installed and position on engine. Extending turnbuckle to its maximum length (one thread evident in adjusting barrel) will effect a narrow profile to aid in lowering component through stage work deck.

NOTE

Because of the remoteness of the hoist operator from the primary FI package and deflection of the hoisting equipment, it is recommended that a technician guide the package and otherwise assist the hoist operator.

l. Aline package with mounting clevises and strut. Install bolts, spacers, washers, bracket, and nuts. (See figure 3-60.)

m. Tighten nuts until a 0.001 to 0.003 inch gap exists between nut and adjoining washer.

n. Remove handler from primary FI package.

o. Remove handler, extension, and sleeve from hoist. Disassemble track (section V).

p. Using 320-grit (or finer) abrasive cloth or paper, clean contact surfaces of ground cable terminal and its mating surface of all protective finishes and foreign material.

q. Connect ground cable to clevis with bolt and washer. Torque bolt to 27-33 in-lb and safetywire.

r. Using milliohmmeter, measure bonding resistance from primary FI package to thrust chamber. Bonding resistance must not exceed 100 milliohms. Measurement may be made as close as possible to bonded juncture if excessive resistance is suspected. Complete step s within 24 hours of completion of resistance check; otherwise repeat resistance check.

s. Apply a coat of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to bonded areas.

t. Weld instrumentation lines. (Refer to section VI for welding requirements.) Lines may be welded in any sequence that results in efficient use of weld and purge times.

u. Connect electrical connectors (paragraph 3-31) P100, P101, P102 (on engines not incorporating MD233 change), P103, and P104.

v. Remove protective material and install 2 seals, filter, and accumulator hose with bolts and washers. Install recessed side of filter next to instrumentation package. Torque bolts to 56-62 in-lb and safetywire.

w. If accumulator hose touches electrical cable (electrical cable connector P3), apply 2 layers of tape 602 (Moxness Products, Inc) or tape 2650 (Johnson and Johnson, Inc) to electrical cable in area where hose and cable touch.

NOTE

It is permissible for the accumulator hose to touch the taped portion of the electrical cable.

x. Reinstall all line support clamps (section I), and torque screws to 24-30 in-lb.

y. Refer to section IV for test requirements.

3-253. PROPELLANT UTILIZATION VALVE.

3-254. REMOVING PROPELLANT UTILIZATION VALVE. (See figure 3-61.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I

b. Disconnect electrical connectors (paragraph 3-30) P36 and P119.

c. Cut PU valve inlet pressure line and outlet pressure line. (Refer to section VI for tube cutting requirements.) Protect open lines.

d. Remove nuts, washers, and brackets that secure PU valve to oxidizer turbopump. Remove PU valve, seal, and spacer. Install clean protective closures (paragraph 3-258).

e. If PU valve is to be replaced, remove inlet pressure and outlet pressure line adapters with seals and seal bleed plugs with gaskets for installation of adapters and plugs on replacement valve. Install clean protective closures (paragraph 3-258).

3-255. INSTALLING PROPELLANT UTILIZATION VALVE. (See figure 3-61.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure PU valve, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. If PU valve is being replaced, install inlet and outlet pressure line adapters with seals, and seal bleed plugs with gaskets. Torque inlet and outlet pressure line adapters to 67-73 in-lb. Tighten seal bleed plugs fingertight.

NOTE

Seal bleed plugs will be removed during leak test. Following leak test, bleed plugs will be reinstalled, torqued to 22-28 in-lb, and safetywired.

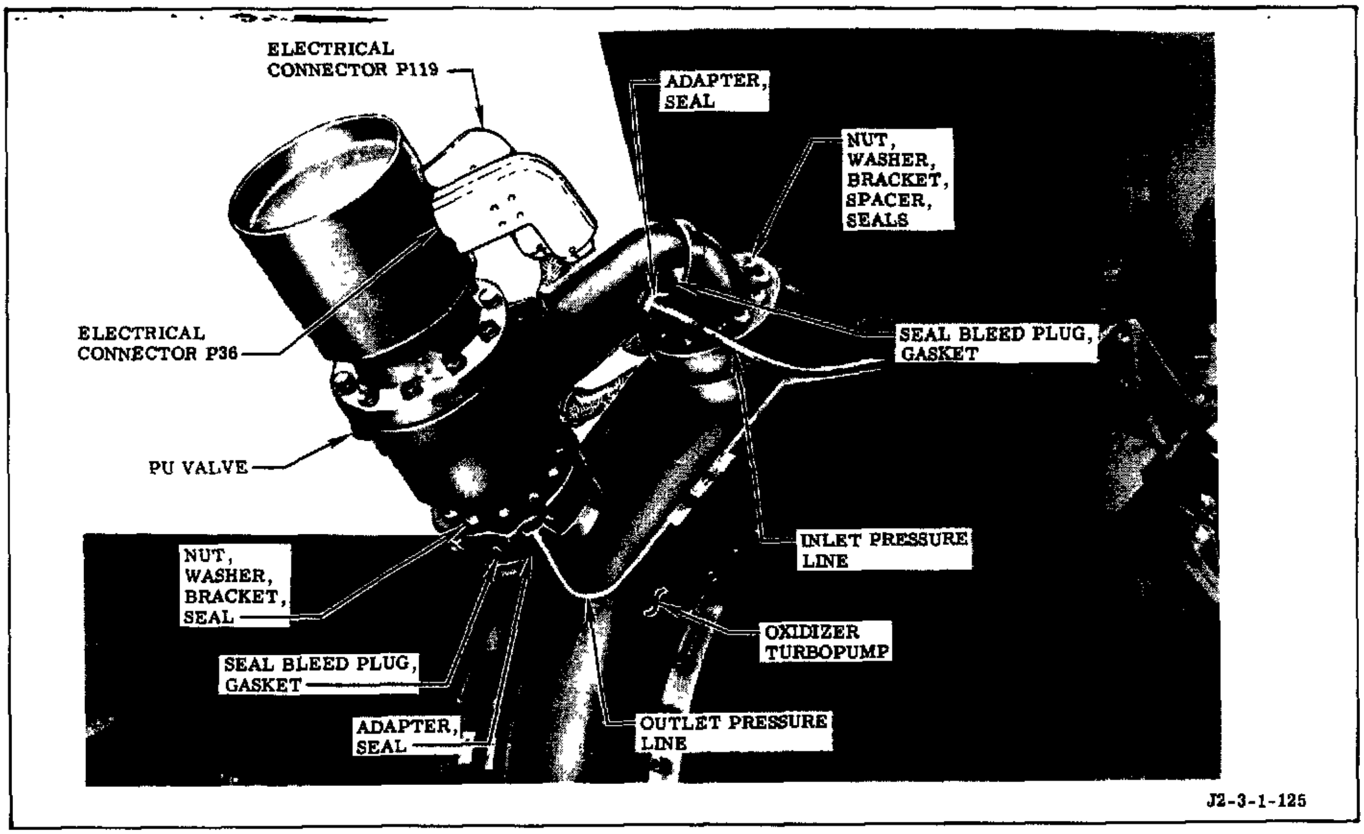


Figure 3-61. Propellant Utilization Valve

d. Remove protective material from PU valve and oxidizer turbopump mating ports. Install seals, spacer, and PU valve and secure with washers, brackets, and nuts. Torque nuts to 65-71 in-lb.

e. Install electrical connectors (paragraph 3-31) P36 and P119.

f. Remove protective material, and weld PU valve inlet pressure and outlet pressure lines. (Refer to section VI for welding requirements.)

g. Refer to section IV for test requirements.

3-256. PROTECTIVE CLOSURES.

3-257. REMOVING PROTECTIVE CLOSURES.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

WARNING

The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

b. Use a clean nylon cloth No. 7815 (Victor Gloves, Inc), or equivalent, dampened with cleaning compound (MIL-C-81302) and clean any dirt or contaminants from component and/or closure.

CAUTION

Sliding or moving closures across sealing surfaces or prying on closures or sealing surfaces will result in damage to sealing surfaces and system leakage.

c. Hold closure against component opening and completely remove all tape and/or attaching hardware. Do not slide closure across sealing surface.

d. Carefully lift closure from opening. If closure does not loosen easily from flange of opening, tap closure gently with a rubber mallet. Do not pry on closure or sealing flanges of component, and do not slide closure across sealing surface.

e. If a protective material (Aclar film, etc) was used between closure and sealing surface, make sure all protective material is removed and discarded.

3-257A. REMOVING PROTECTIVE COVERS FROM INLET DUCT TORSIONAL RINGS. (See figure 3-61A.)

a. Remove fasteners (if applicable, open latch) attaching cover section to adjacent cover sections.

b. Remove 3 cover sections from inlet duct torsional ring.

c. Remove 6 clips from inlet duct nut plates.

d. If required, remove pressure-sensitive tape from drain holes on downstream side of inlet duct flange joint.

3-258. INSTALLING PROTECTIVE CLOSURES.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

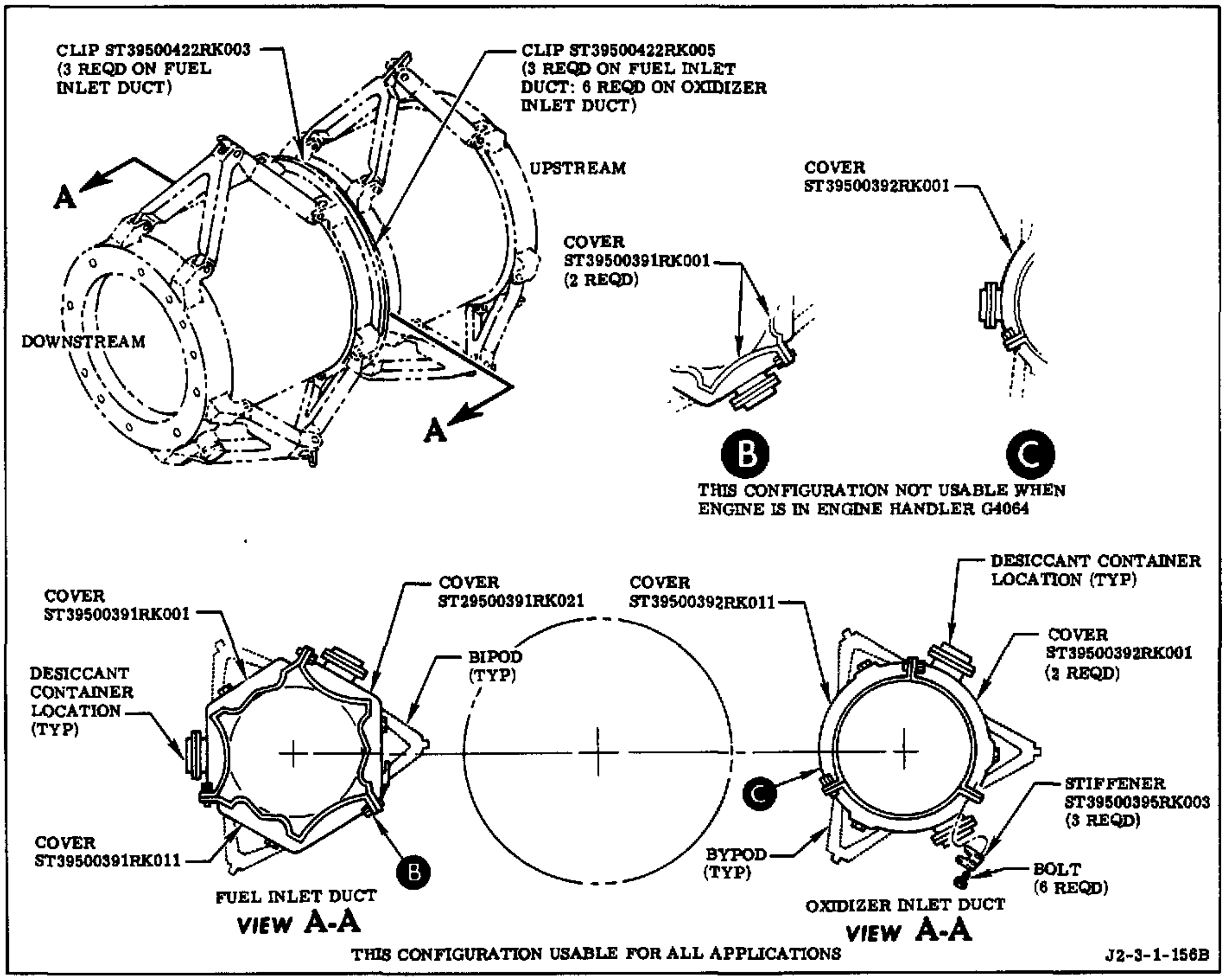


Figure 3-61A. Protective Covers for Inlet Duct Torsional Rings

b. Obtain clean protective closures. (Refer to R-3825-4 for part numbers.)

CAUTION

Using closures that have sponge rubber on sealing surfaces can contaminate component or system.

c. Install threaded closures (caps and plugs with packings) fingertight plus 1/4 turn.

d. When desiccant is required, the number of units is indicated on the closure, except closure ST3950263RKL001, which requires 1/6 unit. Install desiccant as outlined in R-3825-1B.

e. When closures are to be installed on MFV, MOV, STDV, or helium regulator assembly (pneumatic control package), proceed to step h.

CAUTION

Sling or moving closures across sealing flanges will damage sealing surfaces and result in system leakage.

- Turning the fastener in excess of one-quarter turn after the fastener contacts the closure may cause the plastic fastener to break.

f. Position closure on component and/or engine opening and hold closure firmly against flange. Do not slide or turn closure on sealing flanges. Install and tighten attaching fasteners until head of fastener contacts closure plus 1/4 turn. Do not exceed 1/4 turn after fastener contacts closure.

g. If gaps exist between closure and flange of component after tightening fasteners, apply pressure-sensitive tape RB0195-002 (Rocketdyne) around flange and closure joint. Do not apply tape to threads or mating surfaces. Disregard the remainder of this procedure.

h. Obtain a piece of clean Aclar No. 33C film (Allied Chemical Corp), 0.002-inch minimum thickness large enough to cover flange and periphery of opening in component. When installing a closure that has desiccant installed, remove center portion of film (approximately 15 percent smaller than opening in component).

i. Place Aclar film over flange of opening and secure to periphery with one layer of pressure-sensitive tape RB0195-002 (Rocketdyne). Do not apply tape to threads or sealing surfaces.

j. Install closure over Aclar film, and secure closure to component with pressure-sensitive tape RB0195-002 (Rocketdyne). Seal all bolt-holes and edges of closure with tape RB0195-002.

3-258A. INSTALLING PROTECTIVE COVERS ON INLET DUCT TORSIONAL RINGS. (See figure 3-61A.)

a. For fuel inlet duct, obtain items 1 through 5. Items 6 and 7 may be substituted for items 1 and 2 if engine is not in Engine Handler G4064.

(1) Covers ST39500391RK001, ST39500391RK011, and ST39500391RK021 (one each).

(2) Bolts NAS1004-6A or NAS501-4-7A (4 required).

(3) Clip ST39500422RK003 (3 required).

(4) Clip ST39500422RK005 (3 required).

(5) Pressure-sensitive tape RB0195-002 (Rocketdyne). (Required only if fuel inlet duct torsional ring incorporates drain holes.)

(6) Covers ST39500391RK001 (3 required).

(7) Bolts NAS1004-6A or NAS501-4-7A (6 required).

aA. For oxidizer inlet duct obtain items 1 through 5. Item 6 may be substituted for item 1 if engine is not in Engine Handler G4064.

(1) Covers ST39500392RK001 (2 required) and ST39500392RK011 (1 required).

(2) Bolts NAS1004-6A or NAS501-4-7A (6 required).

(3) Clip ST39500422RK005 (6 required).

(4) Stiffener ST39500395RK003 (3 required).

(5) Pressure-sensitive tape RB0195-002 (Rocketdyne).

(6) Cover ST39500392RK001 (3 required).

b. If torsional rings have drain holes, cover them with pressure-sensitive tape.

c. Install 3 clips ST39500422RK003 over fuel inlet duct nut plates located between legs of bipods, and 3 clips ST39500422RK005 over fuel inlet duct nut plates located between bipods. Install 6 clips ST39500422RK005 over oxidizer inlet duct nut plates. Clips must be installed to protect cover gaskets.

d. Position cover sections around torsional rings with side of cover marked DOWNSTREAM SIDE on downstream side of rings, and desiccant container located between bipods. If inlet duct support frames are installed, leaving a minimum of one support frame on duct at all times, individually remove and reinstall each support frame to place closure segments around rings.

e. Install cover sections, connecting each section to adjacent section flange with bolts. When installing oxidizer covers, install stiffeners ST39500395RK003 (with beveled edge against cover) under boltheads. Do not tighten bolts.

f. Make sure cover gasket seats on duct flange. If interference exists in bipod area that prevents proper seating of cover gasket, cut out cover gasket at bipod area on downstream side of cover a maximum of 2 inches (same as cutout on upstream side of cover), using razor-sharp instrument. Tighten bolts evenly until cover flanges mate and gasket seats on duct.

g. Install 4 half-unit bags of desiccant (MIL-D-3464) in each desiccant container. Install desiccant as outlined in R-3825-1B.

3-259. PURGE CONTROL VALVE.

3-260. REMOVING PURGE CONTROL VALVE (See figure 3-62.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

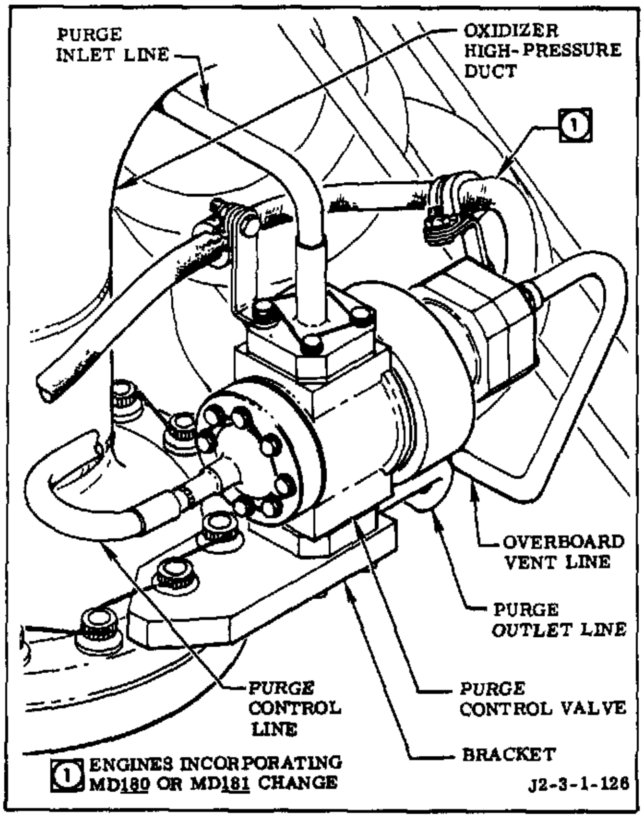


Figure 3-62. Purge Control Valve

b. Cut purge control line. (Refer to section VI for tube cutting requirements.) Protect open lines.

c. Remove bolts and washers (on engines incorporating MD180 or MD181 change, remove bracket) that secure overboard vent line to purge control valve. Remove seal, and protect open ports and sealing surfaces.

d. Remove bolts and washers (on engines incorporating MD180 or MD181 change, remove bracket) that secure purge inlet line to purge control valve. Remove seal, and protect open ports and sealing surfaces.

e. Remove bolts and washers that secure purge outlet line and purge control valve to bracket. Remove purge control valve and seal. Remove protective material from purge control valve and mating flanges, and install clean protective closures (paragraph 3-258).

3-261. INSTALLING PURGE CONTROL VALVE. (See figure 3-62.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure purge control valve, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Remove protective material from purge outlet line flange and mating flange on purge control valve. Install seal and purge control valve and secure to bracket with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

d. Remove protective material from overboard vent line flange and mating flange on purge control valve. Install seal and secure overboard vent line and seal to purge control valve with bolts and washers (on engines incorporating MD180 or MD181 change, install bracket). Torque bolts to 41-45 in-lb and safetywire.

e. Remove protective material from purge inlet line flange and mating flange on purge control valve. Install seal and secure inlet line and seal to purge control valve with bolts and washers (on engines incorporating MD180 or MD181 change, install bracket). Torque bolts to 41-45 in-lb and safetywire.

f. Weld control line. (Refer to section VI for welding requirements.)

g. Refer to section IV for test requirements.

3-262. PURGE RESTRICTORS AND CHECK VALVES.

3-262A. This procedure is applicable to purge restrictors and check valves shown in figure 3-62A. For GG oxidizer and oxidizer injector purge check valves, refer to their respective removal and installation procedures.

3-263. REMOVING PURGE RESTRICTORS AND CHECK VALVES.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

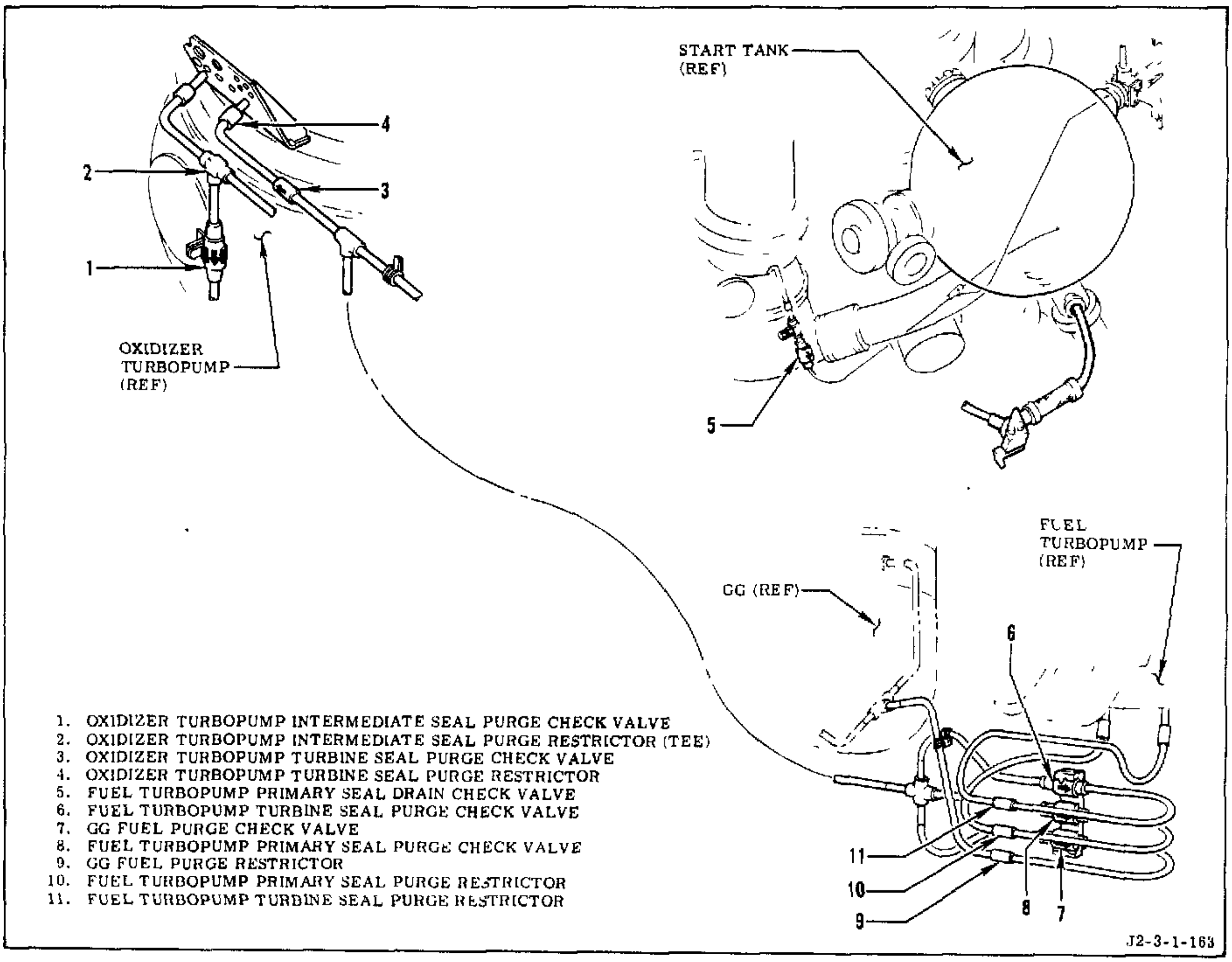


Figure 3-62A. Purge Restrictors and Check Valves

b. Remove support clamps as required to permit removal of restrictor and/or check valve.

c. Cut purge restrictor and/or check valve inlet and outlet lines, and remove restrictor and/or check valve. (Refer to section VI for tube cutting requirements.)

d. Protect open lines.

3-264. INSTALLING PURGE RESTRICTORS AND CHECK VALVES.

a. If check valve is being replaced, verify that purge and seal drain check valve preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Make sure purge restrictor and/or check valve and mating lines are clean, free of damage, and OK to install.

c. Position purge restrictor and/or check valve and weld inlet and outlet lines. (Refer to section VI for tube welding requirements.)

d. Install required support clamps. Torque screws to 24-30 in-lb.

e. Refer to section IV for test requirements.

3-264A. <u>REDUNDANT PURGE CHECK VALVE MANIFOLD.</u>

3-264B. REMOVING REDUNDANT PURGE CHECK VALVE MANIFOLD. (See figure 3-62B.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove line support clamp between redundant purge check valve and purge valve.

c. Cut tube between redundant purge check valve and tee. If a weld sleeve is installed between check valve and tee, cut the two tubes downstream of tee. Remove line support clamps and blocks as necessary for cutting. (Refer to section VI for tube cutting requirements.)

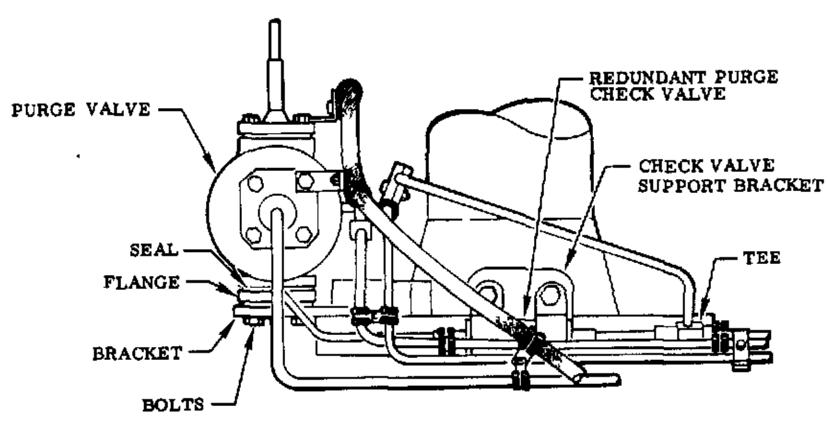


Figure 3-62B. Redundant Purge Check Valve

d. Protect open lines.

e. Remove 4 bolts that secure purge valve to bracket.

f. Remove clamps that support redundant purge check valve.

g. Raise purge valve enough to slide flange from under purge valve and remove check valve manifold, and if attached, tee.

h. Remove seal and protect open ports.

3-264C. INSTALLING REDUNDANT PURGE CHECK VALVE MANIFOLD. (See figure 3-62B.)

a. If redundant purge check valve is being replaced, verify that redundant purge check valve preinstallation tests in R-3825-3, Volume II have been performed.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Temporarily position redundant purge check valve in its installed position and mark tube on outlet side of check valve for trimming. Refer to section VI for tube insertion requirement. If tee downstream of check valve is also being installed, provide a minimum of one-inch between check valve and tee.

NOTE

One-inch between check valve and tee allows for one-time removal of check valve without the need to replace tee.

d. Cut tube on outlet side of check valve on mark established in step c. (Refer to section VI for tube cutting requirements.)

e. Secure manifold flange and seal to purge valve. Leave bolts loose.

f. Secure manifold check valve to check valve support bracket with clamp. Torque clamp screws to 24-30 in-lb.

g. Torque bolts securing manifold flange and purge valve to bracket to 41-45 in-lb and safetywire.

h. If tee downstream of check valve is being installed, mockup lines for tee installation.

i. Weld tubes. Refer to section VI.

j. Install line support clamps and blocks. Torque screws to 24-30 in-lb.

k. Refer to section IV for test requirements.

3-265. START TANK DISCHARGE VALVE.

3-266. REMOVING START TANK DISCHARGE VALVE. (See figures 3-63 and 3-64.)

a. Obtain adapter T-5038463.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

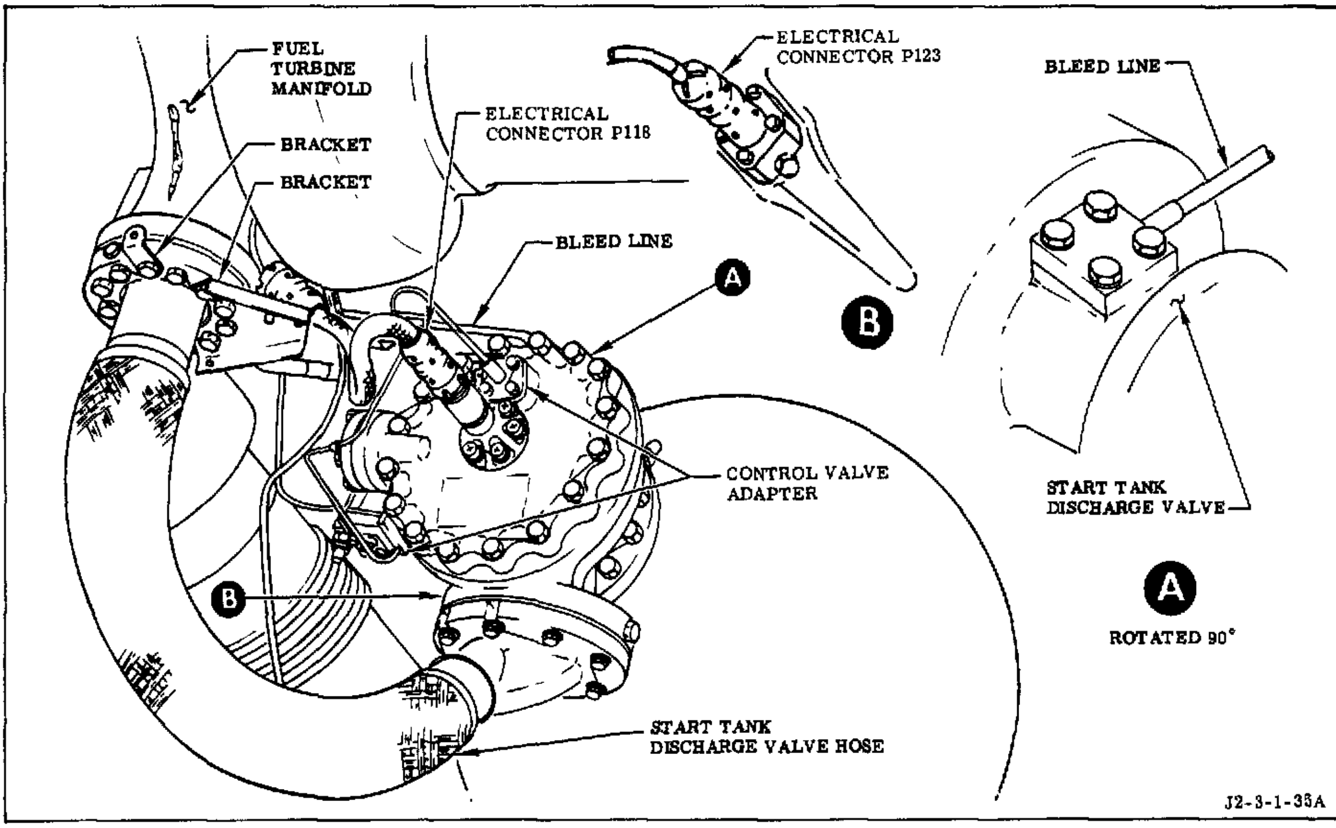


Figure 3-63. Start Tank Discharge Valve and Hose

bA. Before removing start tank discharge valve, make sure start tank has been purged in accordance with R-3825-1B since last time fuel was introduced into system.

c. Disconnect electrical connectors (paragraph 3-30) P118 and P123.

d. Remove clamp that secures control valve adapter tube to bracket on STDV. (See figure 3-64.)

e. Remove bolts and washers that secure both ends of control valve adapter to STDV, and remove bracket and seals. Protect open ports and sealing surfaces. Support control valve and adapter to prevent damage.

f. Remove bolts and washers that secure STDV hose to STDV. Carefully separate flanges and remove seal. Protect open ports and sealing surfaces. Secure hose to prevent interference when removing valve.

g. Remove bolts and washers that secure bleed line to STDV. Remove seal, and protect open ports and sealing surfaces.

h. Using adapter T-5038463, remove bolts and washers that secure STDV to start tank. Remove valve and seal. Protect open ports and sealing surfaces.

i. If STDV is to be replaced, remove and retain (for installation on replacement valve) three 1/8-inch bleed plugs, bolts, washers, bracket, and cap from discharge valve control port. Protect open ports and sealing surfaces.

j. Remove all protective material from ports and sealing surfaces and install clean protective closures (paragraph 3-258).

3-267. INSTALLING START TANK DISCHARGE VALVE. (See figures 3-63 and 3-64.)

a. If STDV is being replaced, verify that STDV preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain adapter T-5038463.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

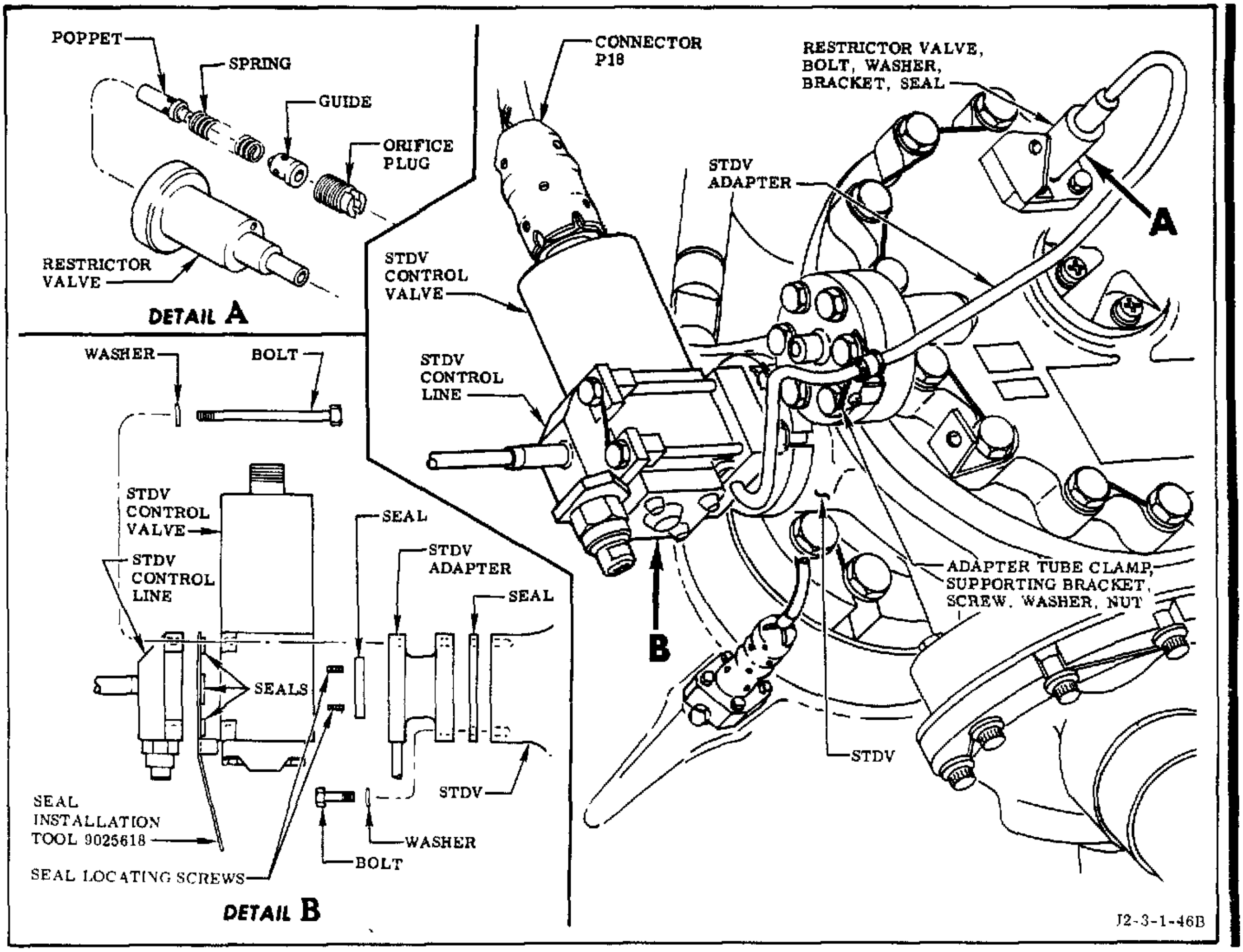


Figure 3-64. Start Tank Discharge Valve Control Valve and Adapter

c. If STDV is being reinstalled, disregard this step and proceed to step d; if STDV is being replaced, proceed as follows:

(1) Remove protective closures and install three 1/8-inch bleed plugs and seals (plugs removed from replaced STDV) on replacement STDV. Tighten bleed plugs fingertight.

NOTE

Bleed plugs will be removed during leak test. Following leak test, bleed plugs will be reinstalled, torque to 22-28 in-lb, and safetywired.

(2) Remove protective closure from STDV control port, install seal, cap, and bracket (cap and bracket removed from replaced STDV) on STDV control port, and secure with bolts and washers. Torque bolts to 41-45 in-lb and safetywire.

d. Inspect and clean start tank as follows:

(1) Remove closure from start tank opening and visually inspect interior of tank for any foreign particles. Insert only oxidizer-clean equipment into tank.

(2) Do not nick or scratch start tank sealing flange or any surface inside of start tank.

(3) If no foreign particles are found inside start tank, disregard remaining substeps and proceed to step e; if foreign particles are found inside start tank, proceed to substep 4.

(4) Obtain a vacuum cleaner with an oxidizer-clean extension long enough to reach bottom of tank.

(5) Install a piece of oxidizer-clean Tygon tubing on vacuum cleaner extension to prevent nicking or scratching any surface inside of tank.

(6) Secure Tygon tubing to vacuum cleaner extension to prevent it from coming off of extension inside of start tank.

(7) Remove all foreign particles from inside of start tank.

e. Remove protective closures (paragraph 3-257). Make sure STDV and mating connections on start tank and adapter are clean and free of damage, and threads in parent metal and/or threaded inserts are free of damage and installed correctly (section I). Protect open ports and sealing surfaces.

f. Make sure STDV is clean, free of damage, and OK to install. Protect open ports and sealing surfaces.

g. Remove protective material from STDV and start tank mating flanges, position seal and STDV on start tank, and secure with bolts and washers. Using adapter T-5038463, cross-torque bolts to 228-252 in-lb and safetywire.

h. Remove protective material from bleed line and STDV mating flanges, install seal, and secure bleed line to STDV with bolts and washers. Cross-torque bolts to 41-45 in-lb and safetywire.

i. Remove protective material from STDV where STDV hose will mate, position seal, and install 2 bolts and washers in flange on STDV where slots in flange of STDV hose will mate. Do not tighten bolts.

j. Remove protective material from STDV hose mating flange for STDV, position STDV hose on STDV, and install remaining bolts and washers. Cross-torque bolts to 314-346 in-lb and safetywire.

k. Remove protective material from control valve adapter and STDV mating flanges, position seal and control valve adapter (with or without control valve installed), and secure with bolts and washers. Cross-torque bolts to 41-45 in-lb and safetywire.

l. Remove protective material from control valve adapter and STDV mating flanges; position seal, control valve adapter, and bracket on STDV control port, and secure with bolts and washers. Cross-torque bolts to 41-45 in-lb and safetywire.

m. Install clamp on control valve adapter tube and secure clamp to bracket with screw, nut, and washer. (See figure 3-64.) Torque screw to 24-30 in-lb.

n. Connect electrical connectors (paragraph 3-31) P118 and P123.

o. Refer to section IV for test requirements.

3-268. START TANK DISCHARGE VALVE ADAPTER.

3-269. REMOVING START TANK DISCHARGE VALVE ADAPTER. (See figure 3-64.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove STDV control valve (paragraph 3-272).

c. Remove screw, nut, and washer from adapter tube clamp and supporting bracket.

d. Remove bolts and washers from adapter control valve end.

e. Remove bolts, washers, and bracket from restrictor valve end of adapter.

f. Remove adapter and seals from both ends of adapter.

g. If adapter is to be replaced, remove and retain orifice plug, guide, springs and poppet from restrictor valve for installation in replacement adapter. (Refer to section I for timing start tank discharge valve.

h. Install protective closures on STDV and adapter (paragraph 3-258), and package orifice plug, guide, spring, and poppet. (Refer to section I for packaging parts for use in propellant and pneumatic systems.)

3-270. INSTALLING START TANK DISCHARGE VALVE ADAPTER. (See figure 3-64.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure mating connections on adapter and STDV are clean and free of damage, threads in parent metal and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Make sure STDV adapter is clean, free of damage, and OK to install.

d. If adapter is being replaced, remove orifice plug, guide, spring, and poppet from replacement adapter, and install poppet, spring, guide, and orifice plug removed from adapter being replaced. Torque orifice plug to 10-15 in-lb. (Refer to section I for timing start tank discharge valve.)

e. Remove protective covering from both mating flanges of adapter and both openings in STDV.

f. Install seals on both openings of STDV, and position adapter in place.

g. Install bracket, washers, and bolts at restrictor valve end of adapter, and install washers and bolts at control valve end of adapter. Torque bolts to 41-45 in-lb and safetywire.

h. Install clamp on adapter tube, and install washer, screw, and nut on clamp and supporting bracket.

i. Install STDV control valve (paragraph 3-273).

j. Refer to section IV for test requirements.

3-271. START TANK DISCHARGE VALVE CONTROL VALVE.

3-272. REMOVING START TANK DISCHARGE VALVE CONTROL VALVE. (See figure 3-64.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I

b. Disconnect electrical connector (paragraph 3-30) P18.

c. Remove bolts and washers that secure STDV control line and control valve to adapter. Remove control valve and seals, and protect open ports and sealing surfaces.

d. If STDV control valve is being replaced, remove 2 seal locating screws from control valve and retain for installation on replacement valve.

e. Remove protective covering from STDV control valve, control line, and adapter, and install clean protective closures (paragraph 3-258).

3-273. INSTALLING START TANK DISCHARGE VALVE CONTROL VALVE. (See figure 3-64.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure mating connections on STDV control valve, control line, and adapter are clean and free of damage, threads in parent metal and/ or threaded inserts are free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Make sure STDV control valve is clean, free of damage, and OK to install.

d. If STDV control valve is being replaced, install 2 seal locating screws (retained from old valve) in replacement valve to correspond with holes in adapter. Seal locating screws must protrude from the control valve 0.180 ±0.060 inch to position seal properly, yet not bottom-out in adapter holes.

dA. Remove protective covering from seal that seals control valve to adapter and inspect seal for evidence of white deposits. Remove loose white deposits by wiping seal with a clean lint-free cloth. Replace seal if deposits cannot be removed by wiping.

e. Remove protective covering from mating flanges of STDV control valve, control line, and adapter and position seal and control valve on adapter.

f. Position 3 seals and seal installation tool 9025618 on control valve, and install STDV control line flange on control valve.

g. Install bolts with washers to secure STDV control line flange and control valve to adapter. Torque bolts to 29-31 in-lb.

h. Apply slight pressure to STDV control line flange and loosen bolts approximately 1/4 turn. Continue to apply slight pressure to control line flange and remove seal installation tool; continue to apply pressure to control line flange and retorque bolts to 29-31 in-lb.

i. Check impression on Teflon tape on seal installation tool to make sure seals are correctly positioned. If tape on installation tool does not have a round impression at each of the 3 seal locations or if tape is cut or torn, remove STDV control line flange and 3 seals and reinstall as outlined in steps f through i.

j. Safetywire bolts.

k. Connect electrical connector (paragraph 3-31) P18.

l. Refer to section IV for test requirements.

3-274. START TANK DISCHARGE VALVE HOSE.

3-275. REMOVING START TANK DISCHARGE VALVE HOSE. (See figure 3-63.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove bolts and washers that secure STDV hose to STDV, position hose away from valve, remove seal, and protect open ports and sealing surfaces.

c. Remove bolts, washers, and brackets that secure STDV hose to fuel turbine manifold, remove hose and seal, and protect open ports and sealing surfaces.

d. If STDV hose is to be replaced, remove plugs and seals at STDV end of hose and retain plugs for reinstallation. Protect open port in hose.

e. Remove all protective material from STDV hose and engine ports, and install clean protective closures (paragraph 3-258).

3-276. INSTALLING START TANK DISCHARGE VALVE HOSE. (See figure 3-63.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure STDV hose, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. If STDV hose was replaced, remove protective material and install plug and seal in port at STDV end of hose and torque to 40-65 in-lb and safetywire. Install plug and gasket in previously installed plug and torque to 22-28 in-lb and safetywire.

d. Position STDV hose on engine, and remove protective material from hose and fuel turbine manifold mating port. Install and secure hose, seal, and brackets with bolts and washers. Torque bolts to 285-315 in-lb and safetywire.

e. Remove protective material from STDV hose and STDV mating port. Install seal using bolts and washers to aline with slotted flange of hose. Secure hose and seal to STDV with remaining bolts and washers. Torque bolts to 314-346 in-lb and safetywire.

f. Refer to section IV for test requirements.

3-277. <u>START TANK DISCHARGE VALVE POTENTIOMETER.</u>

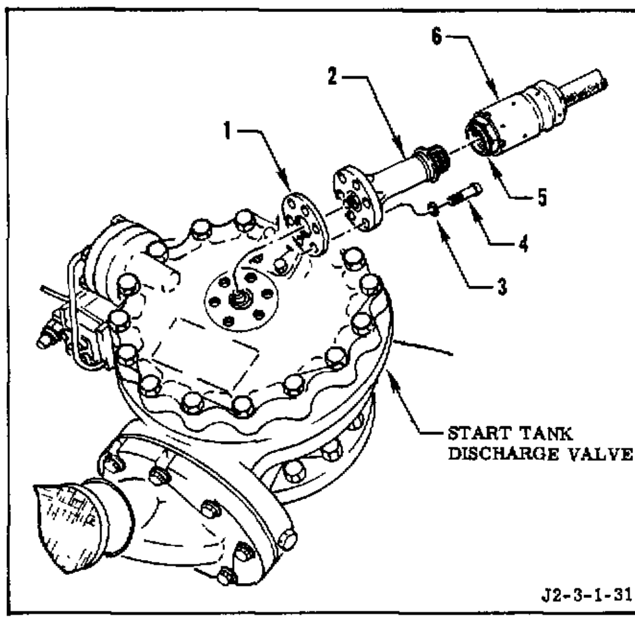
3-278. REMOVING START TANK DISCHARGE VALVE POTENTIOMETER. (See figure 3-65.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove boot (6), and disconnect electrical connector (paragraph 3-30) P118 (5).

c. Remove screws (4) and washers (3) that secure potentiometer (2) to STDV.

d. Carefully pull potentiometer (2) straight out from STDV enough to place a thin 1/4-inch open-end wrench on wrench flats of potentiometer shaft. Using open-end wrench, unscrew potentiometer shaft from STDV piston, and remove potentiometer (2) and seal (1). Install clean protective closures (paragraph 3-258).



Index Number	Description
1	Seal
2	Potentiometer
3	Washer
4	Screw
5	Electrical connector P118
6	Boot

Figure 3-65. Start Tank Discharge Valve Potentiometer

3-279. INSTALLING START TANK DISCHARGE VALVE POTENTIOMETER. (See figure 3-65.)

a. If potentiometer is being replaced, verify that position transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure potentiometer, STDV mating connection, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

c. Install seal (1). Using a thin 1/4-inch wrench, install potentiometer (2) by tightening potentiometer shaft until it bottoms on STDV piston.

d. Secure potentiometer (2) and seal (1) to STDV with washers (3) and screws (4). Cross-torque screws (4) to 72-88 in-lb and safetywire.

e. Connect electrical connector (paragraph 3-31) P118 (5). Position boot (6) over connector.

f. Refer to section IV for test requirements.

3-280. <u>START TANK EMERGENCY VENT VALVE.</u>

3-281. REMOVING START TANK EMERGENCY VENT VALVE. (See figure 3-66.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove support clamps as necessary, noting position and location for reinstallation.

c. Remove nut (11), washer (10), screw (9), and clamps (7, 8) that secure electrical connector P16 (6) to vent valve body.

d. Remove electrical connector P55 (5). (Refer to paragraph 3-30.)

e. Using tube cutter from Special Tool Kit G3127, cut vent line on straight section. (Refer to section VI for tube cutting requirements.) Install clean protective covering on tube ends.

f. Remove bolts (4) and washers (3) that attach vent valve (2) to start tank support-and-fill valve.

g. Remove vent valve (2) and seal (1).

h. Install clean protective closures (paragraph 3-258) on vent valve and support-and-fill valve.

3-282. INSTALLING START TANK EMERGENCY VENT VALVE. (See figure 3-66.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure emergency vent valve, support-and-fill valve mating connection, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Remove protective material from emergency vent valve and support-and-fill valve flanges, install seal (1), and aline and install vent valve (2), washers (3), and bolts (4) on support-and-fill valve.

d. Cross-torque bolts to 61-75 in-lb and safetywire.

e. Remove protective covering from tube ends, and weld vent line. (Refer to section VI for tube welding requirements.)

f. Connect electrical connector P55 (5). (Refer to paragraph 3-31.)

g. Secure electrical connector P16 (6) to vent valve body with clamps (7, 8), screw (9), washer (10), and nut (11). Torque nut to 24-30 in-lb.

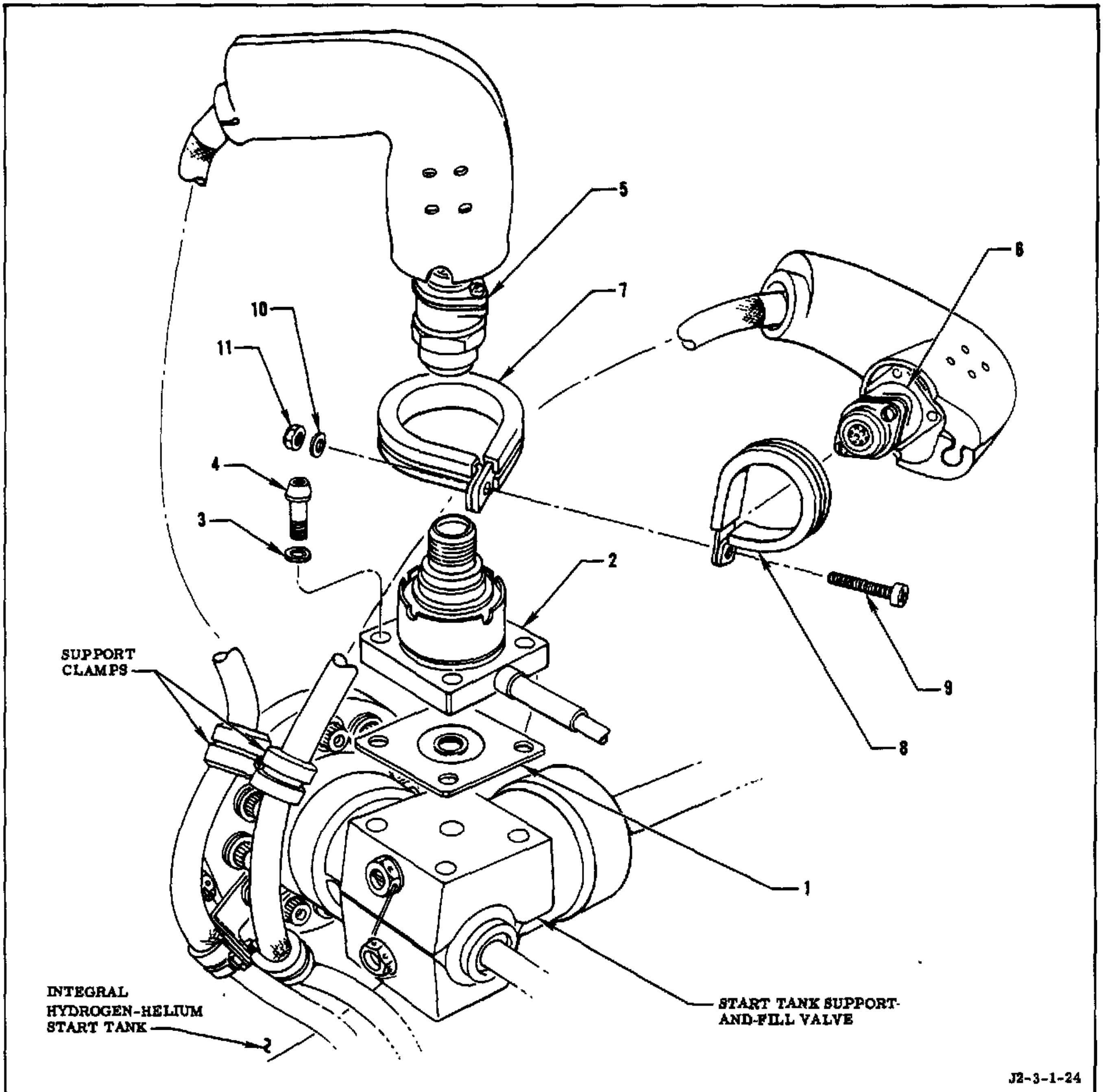
h. Install support clamps in positions and locations noted in removal procedure.

i. Refer to section IV for test requirements.

3-283. <u>START TANK LIQUID REFILL LINE.</u>

3-284. REMOVING START TANK LIQUID REFILL LINE. (See figure 3-3.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.



Index Number	Description	Index Number	Description
1	Seal	7	Clamp
2	Emergency vent valve	8	Clamp
3	Washer	9	Screw
4	Bolt	10	Washer
5	Electrical connector P55	11	Nut
6	Electrical connector P16		

Figure 3-66. Start Tank Emergency Vent Valve

b. Loosen (but do not remove) bolts that attach refill line flange to lower fuel line.

c. Using tube cutter from Special Tool Kit G3127, cut fuel refill tube and install protective covering on tube ends. (Refer to section VI for tube cutting requirements.)

d. Remove screws, washers, blocks, shims, and clamps that attach refill line to brackets.

e. Remove bolts and washers that attach refill manifold flange to lower fuel line, and remove seal.

f. Install clean protective closures (paragraph 3-258) on refill manifold flange and lower fuel line flange.

3-285. INSTALLING START TANK LIQUID REFILL LINE. (See figure 3-3.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closure (paragraph 3-257) from refill line flange, and verify orifice size (0.070 ±0.001 inch).

c. Check orifice protrusion from refill line flange. Maximum protrusion is 0.245 inch. If orifice protrusion is more than 0.245 inch, torque to 20-30 in-lb.

d. Remove protective closure (paragraph 3-257) from lower fuel line tee flange. Make sure refill line, lower fuel line mating connection, and threads in parent metal of lower fuel line tee flange are clean and free of damage.

e. Install seal and refill line on lower fuel line flange. Install bolts and washers, and tighten bolts fingertight. Make sure cap is on seal.

f. Remove protective covering from tube ends, and weld refill line to engine start tank refill line. (Refer to section VI for tube cutting requirements.)

g. Install screws, nuts, clamp, and blocks that attach refill line to thrust chamber. Torque screws to 24-32 in-lb. Screws must be torqued evenly to maintain equal spacing between upper and lower blocks.

h. Torque bolts that attach refill line flange to lower fuel line to 52-58 in-lb and safetywire.

i. Refer to section IV for test requirements.

3-286. <u>START TANK LIQUID REFILL CHECK VALVE MANIFOLD.</u>

3-287. REMOVING START TANK LIQUID REFILL CHECK VALVE MANIFOLD. (See figure 3-3.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove screws, nuts, and clamp that secure check valve to bracket.

c. Remove screws, clamps, and spacers that secure refill line between check valve and fuel ASI line.

d. Remove bolts and washers that secure refill line to fuel ASI line. Remove seal and protect open ports.

e. Remove plastic cap from seal leak port.

f. Using tube cutter from Special Tool Kit G3127, cut refill line above check valve. (Refer to section VI for tube cutting requirements.)

g. Install clean protective closures (paragraph 3-258).

3-288. INSTALLING START TANK LIQUID REFILL CHECK VALVE MANIFOLD. (See figure 3-3.)

a. If check valve manifold is being replaced, verify that start tank liquid refill check valve manifold preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove protective closures (paragraph 3-257). Make sure check valve, tubes, and flange are clean, free of damage, and OK to install.

c. Make sure protrusion of orifice from flange does not exceed 0.245 inch. (See figure 3-66A, detail A.) If orifice protrusion exceeds 0.245 inch, torque orifice to 20-30 in-lb to obtain allowable protrusion.

d. Temporarily position check valve manifold in place, making sure manifold can be correctly mated to fuel ASI line, and mark and cut line or lines above check valve to meet tube fit requirements specified in section VI.

e. Secure check valve to its mounting bracket loosely with clamp, screws, and nuts. Leave check valve free to move under clamp.

f. Install plastic cap on seal leak port, install seal between manifold and fuel ASI line, and secure manifold to fuel ASI line with bolts and washers. Torque bolts to 52-58 in-lb and safetywire bolts.

g. Torque screws that secure check valve to bracket to 38-46 in-lb.

h. Install line support below check valve (between check valve and fuel ASI line) as follows:

(1) Place one line support between manifold line and support bracket and add spacers (4 maximum) to position line support to within 0.063 inch of manifold line (figure 3-66A, detail B).

(2) Install second line support with remaining spacers (a total of 4 spacers must be used including those used in substep 1) and secure supports and spacers with screws. Do not tighten screws.

(3) Torque screws that secure line supports to 12-15 in-lb above running torque or until line support is deflected 0.020 to 0.030 inch (see figure 3-66A, detail C), whichever occurs first.

i. Weld manifold line above check valve. (Refer to section VI for tube welding requirements.)

j. Refer to section IV for test requirements.

3-289. START TANK SUPPORT-AND-FILL VALVE.

3-290. REMOVING START TANK SUPPORT-AND-FILL VALVE. (See figure 3-67.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

aA. Before removing start tank support-and-fill valve make sure start tank has been purged in accordance with R-3825-1B since last time fuel was introduced into system.

b. Remove support clamps as necessary to gain access and remove start tank support-and-fill valve. Note position of clamps for reinstallation.

c. On engines incorporating MD316, MD320, or MD351 change, cut start tank emergency vent line. (Refer to section VI for tube cutting requirements.) Protect open end of lines with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape.

d. Cut start tank initial fill line and pressure instrumentation line (TF1). (Refer to section VI for tube cutting requirements.) Protect open end of lines with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape.

e. On engines incorporating MD316, MD320, or MD351 change, remove clamps that secure electrical connector P16 to start tank emergency vent valve and disconnect electrical connector (paragraph 3-30) P55 from emergency vent valve.

f. On engines not incorporating MD316, MD320, or MD351 change, disconnect electrical connector (paragraph 3-30) P16.

g. Remove all support clamps from gaseous refill line.

h. On engines not incorporating MD254 change, remove nuts, washers, bracket, and bolts that secure gaseous refill line to flange on thrust chamber fuel manifold. Remove seals. Install clean protective closures (paragraph 3-258) on thrust chamber fuel manifold and gaseous refill line.

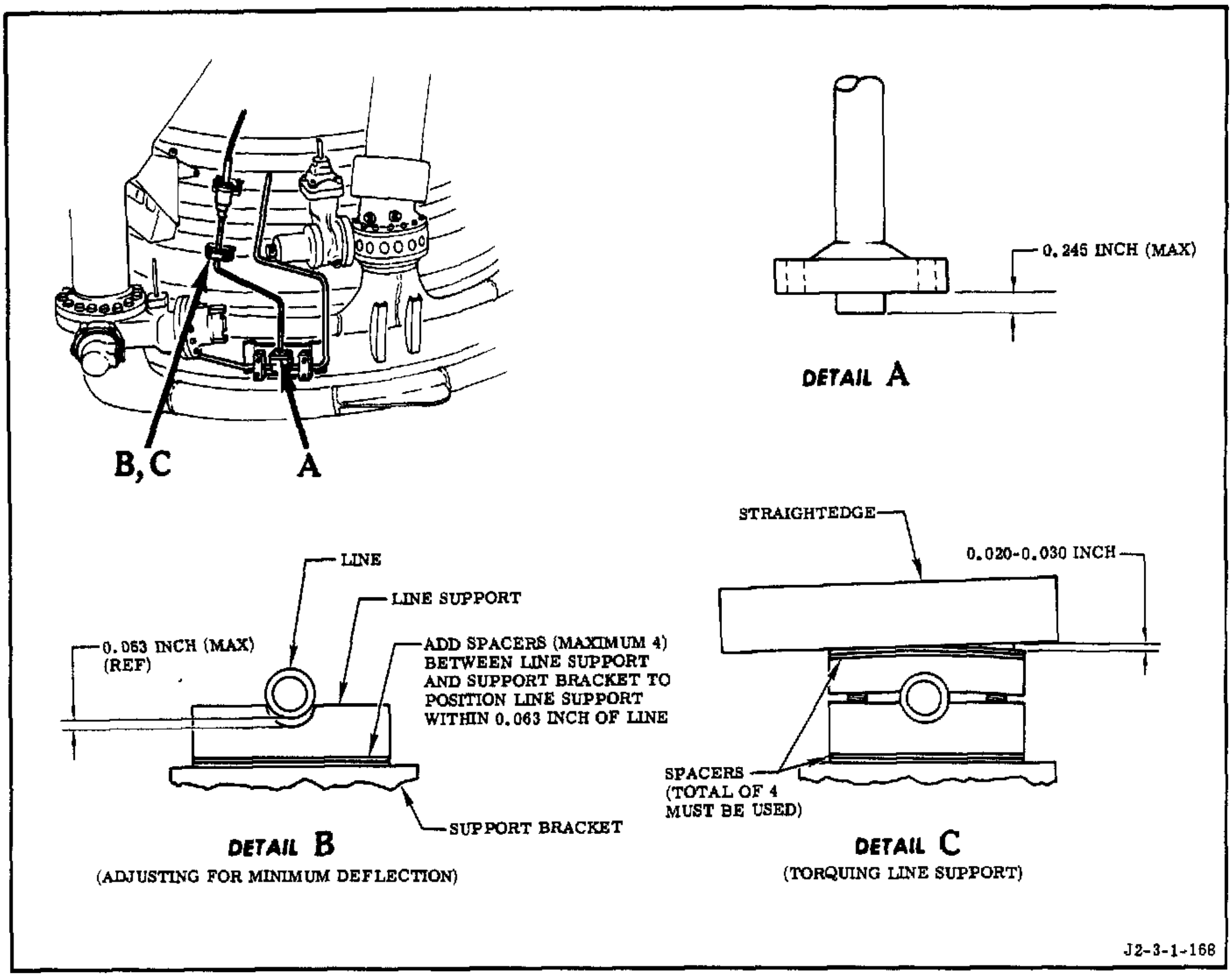


Figure 3-66A. Start Tank Liquid Refill Check Valve Manifold

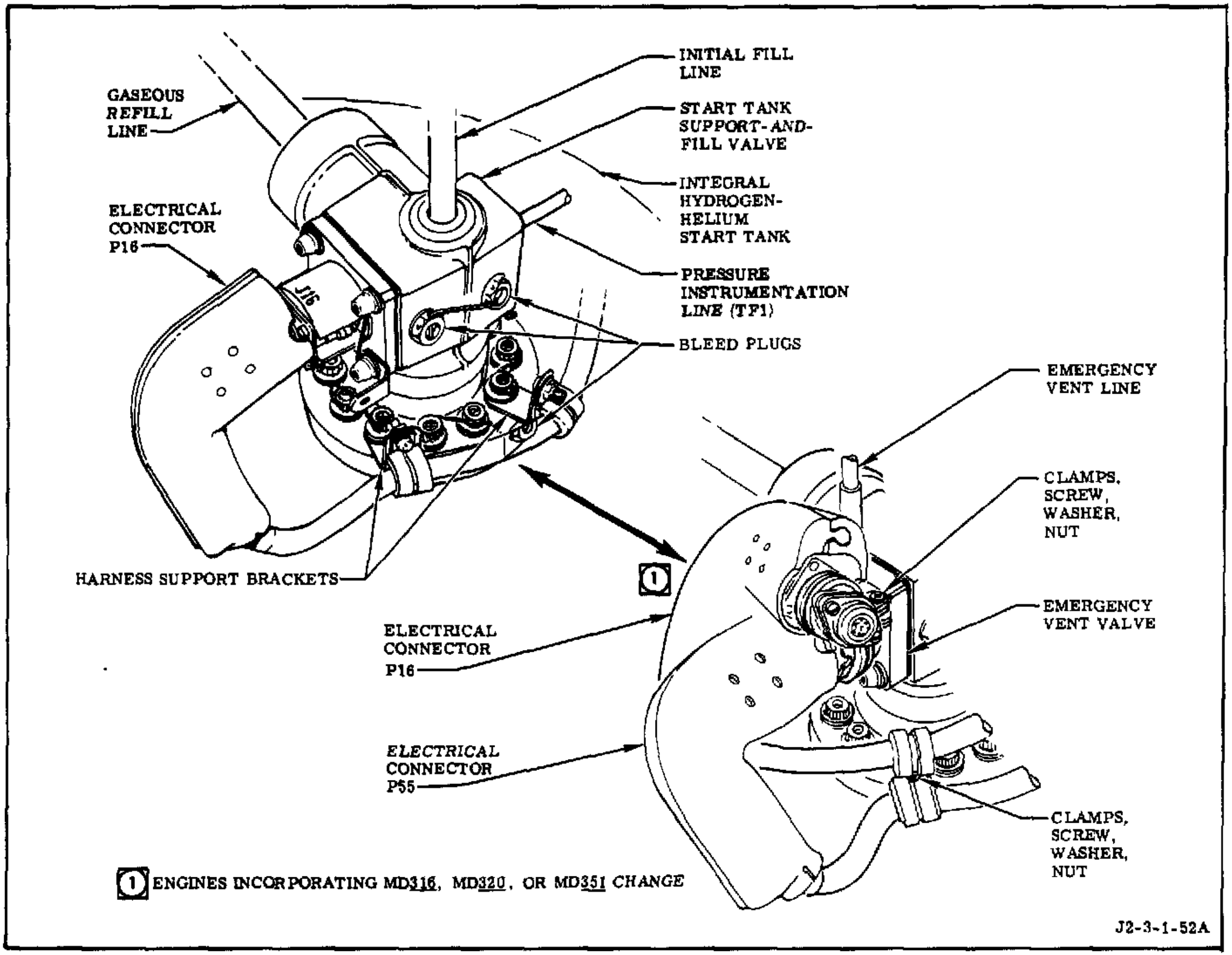


Figure 3-67. Start Tank Support-and-Fill Valve

i. On engines incorporating MD254 change, remove nuts, washers, bracket, and bolts that secure gaseous refill line to flange on thrust chamber fuel manifold. Remove seals and blank plate, and retain plate. Install clean protective closures (paragraph 3-258) on thrust chamber fuel manifold and gaseous refill line.

j. Remove bolts and washers that secure support-and-fill valve to start tank, and remove seal. Leave harness support brackets attached to electrical harness. Protect sealing surfaces of start tank and support-and-fill valve with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape. Do not apply tape to sealing surfaces.

k. If sufficient clearance can be obtained, remove nut, washer, and bolt that secure link assembly and strut assembly to support-and-fill valve, and proceed to step o. If sufficient clearance cannot be obtained to remove bolt that secures link assembly and strut assembly to valve, proceed to step l.

l. Remove nuts, washers, and bolts that secure support-and-fill valve strut assembly and link assembly to thrust chamber. Loosen electrical harness clamps on strut assembly and link assembly to allow movement of strut assembly and link assembly.

m. Move support-and-fill valve to allow removal of bolt that secures strut assembly and link assembly to valve. Protect sealing surfaces of valve and start tank and open port in start tank with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape.

n. Disconnect strut assembly and link assembly from support-and-fill valve by removing bolt, washer, and nut. Do not puncture film covering open port in start tank.

o. Remove start tank support-and-fill valve and gaseous refill line from engine as a unit. Protect open ports with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape.

p. If support-and-fill valve is to be replaced, proceed as follows:

(1) Remove bleed plugs from valve and gaseous refill line, and retain plugs for installation on new valve. Protect open ports with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape.

(2) Remove adapter and seal at port TF1. Retain adapter for installation on new valve.

(3) Cut gaseous refill line and retain for installation on new valve. Protect open ports with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape.

(4) On engines incorporating MD320 or MD351 change, if only the support-and-fill valve is to be replaced, remove bolts and washers that secure emergency vent valve to support-and-fill valve and remove vent valve and seal. Retain vent valve for installation on new support-and-fill valve.

q. Remove tape and polyethylene and/or Aclar film from openings, and install clean protective closures (paragraph 3-258) on all open ports.

3-291. INSTALLING START TANK SUPPORT-AND-FILL VALVE. (See figure 3-67.)

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. If support-and-fill valve is being replaced, verify that start tank support-and-fill valve preinstallation tests in R-3825-3, Volume II have been performed.

aA. Obtain the following:

(1) Heat exchanger oxidizer supply line test plate kit 9019968

(2) One plug RD265-3009-0001

(3) One seal 404659

(4) From components adapter set 9016796

(a) One tee AN938C6

(b) Two reducers AN919-6C

(c) One bleed plug AN814-4C

(d) One burst diaphragm 19-9017276-1

(e) One packing MS28778-4

(f) Three packings MS28778-6

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure start tank support-and-fill valve, gaseous refill line, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape. Do not apply tape to sealing surfaces.

d. If support-and-fill valve is not being replaced, proceed to step e. If support-and-fill valve is being replaced, proceed as follows:

(1) Remove protective material, install bleed plugs (removed from old valve and gaseous refill line) with seals, and tighten plugs fingertight.

NOTE

The bleed plugs will be removed during the leak test. Following the leak test, the bleed plugs will be reinstalled and torqued to 22-28 in-lb. During the prelaunch leak test, the plugs will be safetywired.

(2) If support-and-fill valve is being replaced on engines incorporating MD316, MD320, or MD351 change, install emergency vent valve previously removed from old support-and-fill valve as follows:

(a) Make sure emergency vent valve is clean, free of damage, and OK to install.

(b) Remove protective material, and position and secure seal and emergency vent valve on support-and-fill valve with bolts and washers. Cross-torque bolts to 61-75 in-lb and safetywire.

(c) Make sure replacement support-and-fill valve 557998 or 557998-11 is identified as 557998-41 after installation of emergency vent valve.

(3) Fit and weld gaseous refill line as follows:

(a) Remove protective material and position refill line and support-and-fill valve on engine. Use seals, orifice or blank plate, and attaching hardware to obtain correct fit.

(b) Trim and fit a start tank refill tube 303936 to rigid portion of gaseous refill line and to new support-and-fill valve. Scribe position of weld joints and sections of lines to establish correct alinement for welding.

(c) Remove support-and-fill valve and attaching hardware; gaseous refill line, seals, orifice or blank plate, and attaching hardware; and start tank refill tube 303936 from engine. Protect open ports and sealing surfaces.

(d) Remove protective material, and assemble and weld start tank refill tube to gaseous refill line and to support-and-fill valve. (Refer to section VI for tube welding requirements.) Make sure correct alinement is obtained before welding.

(4) To minimize the possibility of having to remove the support-and-fill valve during leak test, a preliminary leak test of the welds may be made at this time. To perform a preliminary leak test, proceed as follows; otherwise proceed to step e.

(a) Remove adapter, seal, and protective material from port TF1, and install plug RD265-3009-0001 and seal 404659 in support-and-fill valve. Torque plug to 40-55 in-lb.

(b) Remove protective covering from support-and-fill valve outlet port and install plate 9022568, seal RD261-3014-0042, and bolts, washers, and nuts (from adapter set 9022569). Torque bolts to 210-280 in-lb.

(c) Install bleed plug AN814-4C with packing MS28778-4 in plate 9022568. Torque plug to 40-65 in-lb.

(d) Remove protective covering and install heat exchanger oxidizer supply line test plate kit 9019968 and seal on gaseous refill line with bolts, washers, and nuts. Torque bolts to 61-75 in-lb.

(e) Assemble one burst diaphragm 19-9017276-1 and 2 reducers AN919-6C with 3 packings MS28778-6 on one tee AN938C6. Torque reducers and diaphragm to 100-150 in-lb.

(f) Install diaphragm, reducers, and tee (assembled in step e) on start tank gaseous refill adapter (installed in step d). Torque to 135-185 in-lb.

(g) Connect a regulated supply of helium (section I) to adapter on start tank gaseous refill line and apply 30-33 psig pressure to line.

(h) Using leak-test compound (MIL-L-25567), leak-test welds. Leakage is not allowable.

(i) Reduce pressure in line and valve to zero and disconnect pressure source from adapter.

(j) Remove test equipment and return to adapter sets.

(k) Remove plug RD265-3009-0001 and seal 404659 from start tank support-and-fill valve port TF1, and install adapter and seal in port TF1. Torque adapter to 67-73 in-lb.

(l) Protect all openings with clean polyethylene and/or Aclar No. 33C (Allied Chemical Corp) and tape. Do not apply tape to sealing surfaces.

e. Position support-and-fill valve on engine and install link and strut on valve with bolts, washer, and nut. Make sure not to puncture protective covering over start tank opening and/or flange. Torque nut to 36-47 in-lb.

f. Remove protective covering from start tank and support-and-fill valve mating ports. Install seal, and secure harness support brackets and valve to tank with bolts and washers. Cross-torque bolts to 253-279 in-lb and safetywire.

g. If link and strut are not disconnected from thrust chamber, proceed to step h. If link and strut are disconnected, reconnect link and strut to thrust chamber with bolts, washers, and nuts. Torque nuts to 36-47 in-lb.

h. Remove protective covering from gaseous refill line and mating port on thrust chamber fuel manifold. On engines not incorporating MD254 change, install seals and bracket, and secure refill line to fuel manifold with bolts, washers, and nuts. On engines incorporating MD254 change, install seals, blank plate, and bracket, and secure refill line to fuel manifold with bolts, washers, and nuts. Cross-torque bolts to 43-47 in-lb.

i. Remove protective material, and weld initial fill line and start tank pressure instrumentation line (TF1). (Refer to section VI for tube welding requirements.)

j. On engines incorporating MD316, MD320, or MD351 change, proceed as follows:

(1) Remove protective material, and weld start tank emergency vent line. (Refer to section VI for tube welding requirements.)

(2) Connect electrical connector (paragraph 3-31) P55.

(3) Secure electrical connector P16 to start tank emergency vent valve with 2 clamps, screw, washer, and nut. Torque screw to 24-30 in-lb.

k. On engines not incorporating MD316, MD320, or MD351 change, connect electrical connector (paragraph 3-31) P16.

l. Reinstall and position all support clamps previously removed, and torque screws to 25-30 in-lb.

m. Refer to section IV for test requirements.

3-292. START TANK VENT-AND-RELIEF VALVE.

3-293. REMOVING START TANK VENT-AND-RELIEF VALVE. (See figure 3-68.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Before removing vent-and-relief valve, make sure start tank has been purged in accordance with R-3825-1B since last time fuel was introduced into system.

c. If vent-and-relief valve is to be reinstalled, proceed to step d. If vent-and-relief valve is to be replaced, proceed to step i.

d. Remove attaching hardware from vent line support bracket and remove support clamps that secure start tank vent-and-relief valve vent and control lines.

e. If engine is installed in a stage, disconnect vent and control lines from stage using applicable Stage Contractor procedures. Install clean protective closures (paragraph 3-258) and adequately support vent and control lines.

f. Remove bolts and washers that secure vent-and-relief valve to start tank. Remove seal and install clean protective closures (paragraph 3-258).

g. Remove start tank vent-and-relief valve with control and vent lines attached. Maintain adequate support of valve and lines, to prevent unnecessary loads being imposed on bellows sections or weld joints while valve and lines are uninstalled.

h. Disregard remainder of this procedure.

i. Cut vent-and-relief valve vent and control lines. (Refer to section VI for tube cutting requirements.) Protect open line ends.

j. Remove bolts and washers that secure vent-and-relief valve to start tank. Remove seal and install clean protective closures (paragraph 3-258).

3-294. INSTALLING START TANK VENT-AND-RELIEF VALVE. (See figure 3-68.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. If vent-and-relief is being reinstalled proceed to step c. If vent-and-relief was replaced proceed to step j.

c. Remove protective closures (paragraph 3-257). Make sure control and vent lines, and mating flanges of start tank and vent-and-relief valve are clean and free of damage, and threads in parent metal and/or threaded inserts are free of damage and installed correctly (section I).

d. Make sure vent-and-relief valve is clean, free of damage, and OK to install.

e. Install seal and position vent-and-relief valve on start tank. If engine is installed in a stage aline vent and control lines with their customer connect ports and support lines. If engine is in engine handler install vent and control lines in fluid lines interface support.

f. Install bolts and washers that secure vent-and-relief valve to start tank. Torque bolts to 114-126 in-lb and safetywire.

g. If engine is installed in a stage, connect control and vent lines to stage using applicable Stage Contractor procedures.

h. Position control and vent lines on fluid line support brackets and install support clamps. Torque support clamp screws to 24-30 in-lb and torque support bracket bolts to 25-30 in-lb.

i. Refer to section IV for test requirements and disregard remainder of this procedure.

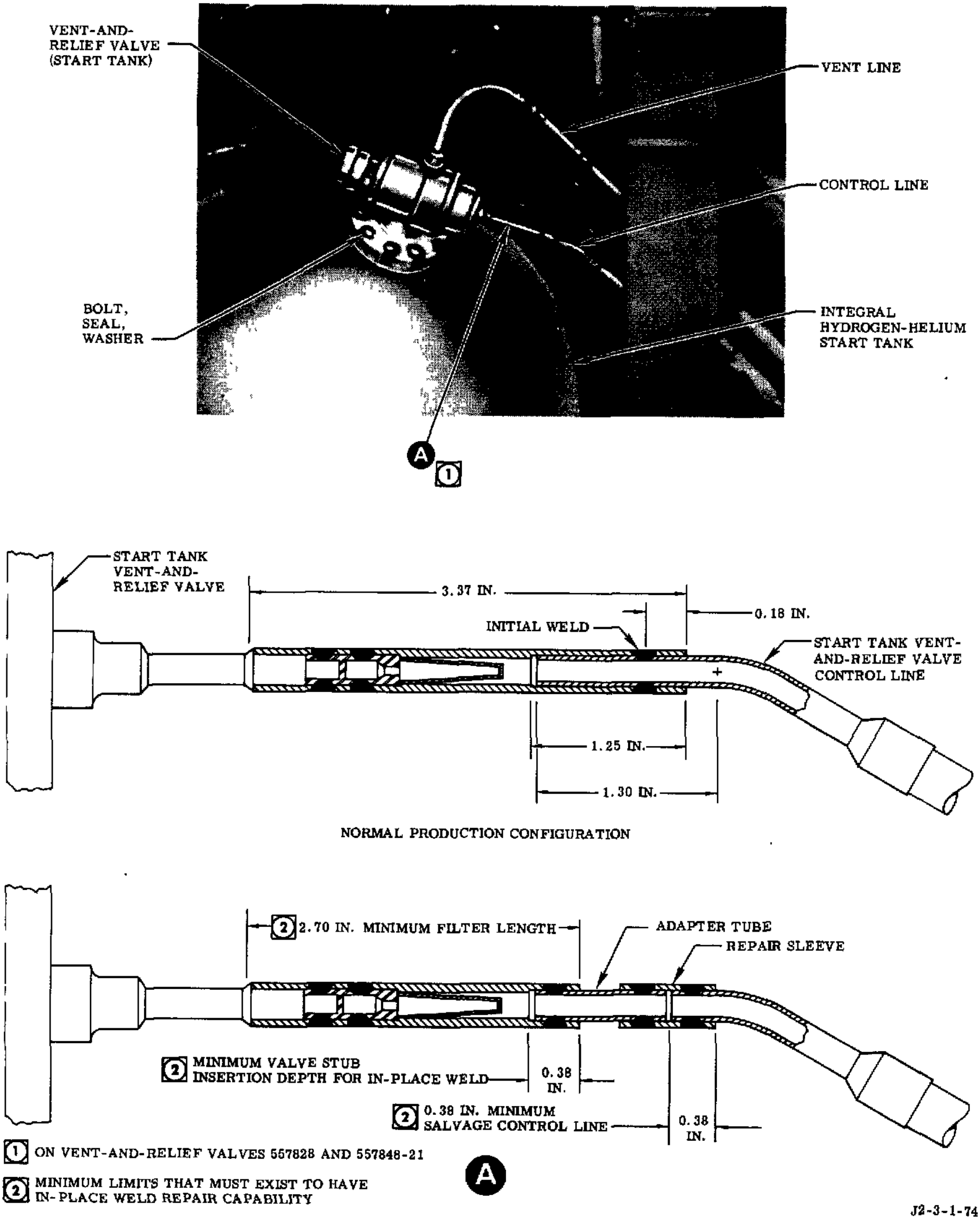


Figure 3-68. Start Tank Vent-and-Relief Valve

j. Remove protective closures (paragraph 3-257). Make sure mating flanges of start tank and vent-and-relief valve are clean and free of damage, and threads in parent metal and/or threaded inserts are free of damage and installed correctly (section I).

k. Make sure vent-and-relief valve is clean, free of damage, and OK to install.

l. Install seal, position vent-and-relief valve on start tank, and install bolts and washers that secure vent-and-relief valve to start tank. Torque bolts to 114-126 in-lb and safetywire.

m. Weld control and vent lines. (Refer to section VI for tube welding requirements.)

n. Refer to section IV for test requirements.

3-295. THRUST CHAMBER INJECTOR.

3-296. REMOVING THRUST CHAMBER INJECTOR (ENGINE HANDLER). The thrust chamber injector (figure 3-69) may be removed and reinstalled but not replaced without affecting engine calibration.

a. Obtain the following equipment:

(1) Suitable equipment to support injector (213 pounds) during removal from an engine in the horizontal position

(2) Guide pins (2 required). (Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(3) Adapter T-5044412

(4) Support ST3950166RKL001

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove purge control valve as follows: (See figure 3-62.)

(1) Cut purge inlet line. (Refer to section VI for tube cutting requirements.)

(2) Cut the following lines (refer to section VI for tube cutting requirements) aft of oxidizer dome and thrust chamber flange joint:

(a) Purge control line.

(b) Purge outlet line.

(c) Overboard vent line.

(3) Remove screws, washers, and nuts that secure igniter cable and clamps to purge control valve.

(4) Remove bolt, washer, nut, and clamp that secure control line.

(5) Remove purge control valve and support bracket from engine.

d. Remove oxidizer high-pressure duct (paragraph 3-209).

e. Install closures on all open ports (paragraph 3-258).

f. Remove MOV (paragraph 3-187).

g. Disconnect SIC as follows:

(1) Measure pressure in SIC as outlined in R-3825-1B; then depressurize cables by backing off pressurizing valve locknut (figure 3-11) 1/2 to 1 turn and depressing valve cores.

(2) Remove pressurizing valves, nuts, and washers from pressurizing bosses. Install clean protective closures on all open ports (paragraph 3-258).

(3) Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG SIC and remove bracket.

CAUTION

Care must be taken throughout this procedure, to prevent damage to the SIC pressurizing lines.

(4) Remove remaining bolts that attach GG SIC to ECA.

CAUTION

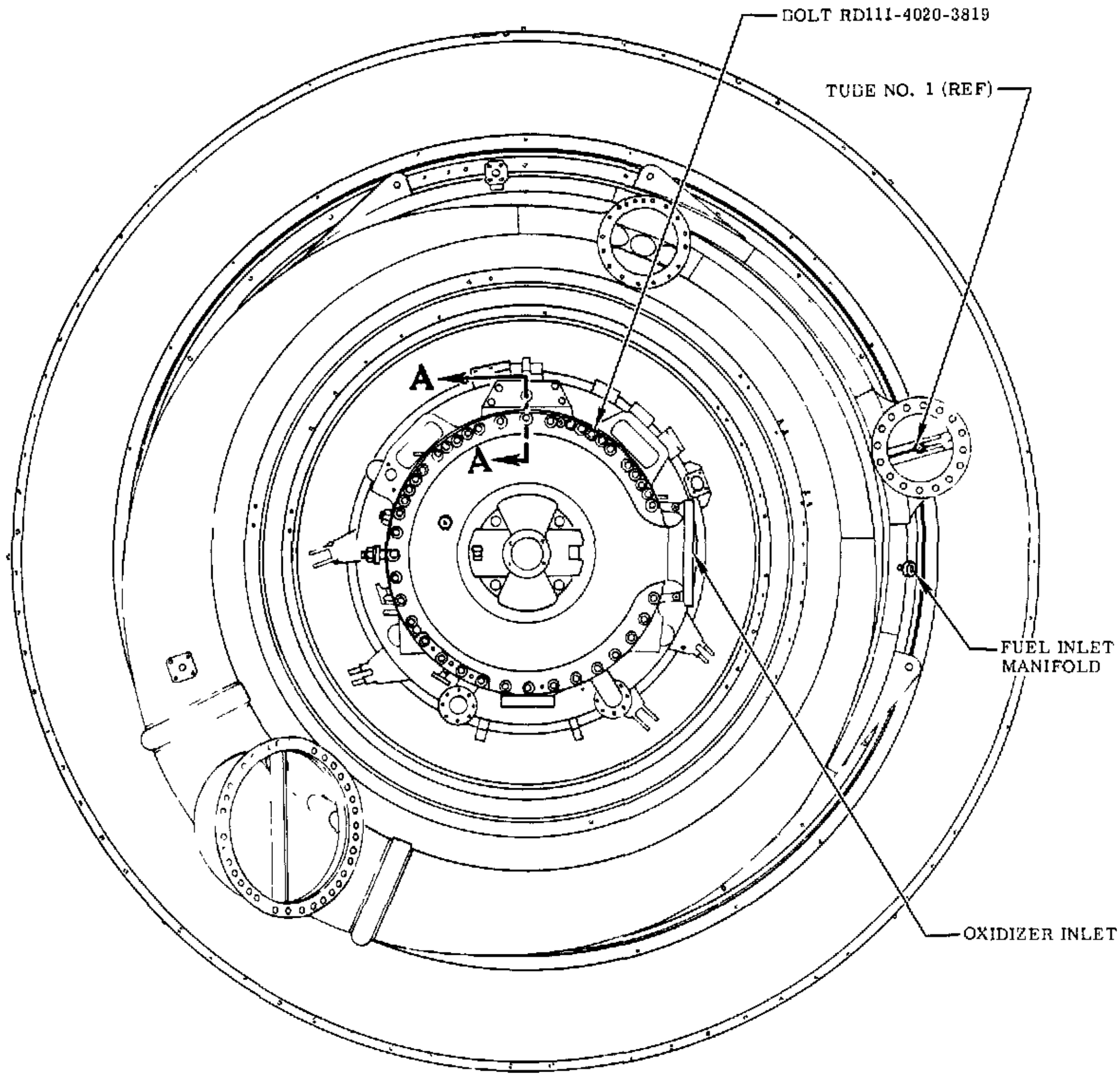
Tipping or side motion of the SIC bell housing before the cable connector is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

(5) Remove GG SIC bell housing from ECA by pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

(6) Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(7) Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows:



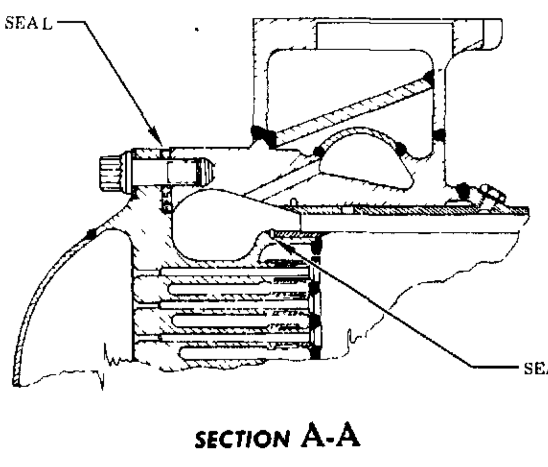


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Figure 3-69. Thrust Chamber Injector

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

(a) Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

(b) Place support ST3950166RKL001 on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(c) Tighten bolts until flange on support seats on SIC bell housing flange.

(8) Install clean protective closures (paragraph 3-258) on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

(9) Temporarily secure cables to engine.

(10) Disconnect electrical connectors (paragraph 3-30) P1, P2, and P3, and install clean protective closures (paragraph 3-258) on connectors and ECA.

(11) Remove ASI SIC pressurizing tube support clamps, except do not remove clamps that clamp pressurizing line to SIC.

(12) Remove bolts that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC housing before the cable connector is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing fron anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

(13) Remove ASI SIC bell housing from ECA by pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

(14) Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(15) Install support ST3950166RKL001 on bell housing of ASI SIC NA5-27448 as follows:

(a) Place support ST3950166RKL001 on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(b) Tighten bolts until flange on support seats on SIC bell housing flange.

(c) Install clean protective closures (paragraph 3-258) on ASI SIC NA5-27448 support, or bell housing of SIC NA5-27448T1, and on ECA.

CAUTION

While heating the splice, care must be taken to prevent overheating or burning the adjacent components.

(16) Carefully heat line splice (sleeves), and remove SIC pressurizing bosses, lines, and sleeves from stubout on SIC bell housing. Protect open ends of lines.

(17) Remove SIC support clamps. Note position of clamps for reinstallation.

h. On engines not incorporating MD338 change, disconnect electrical connector (paragraph 3-30) P19 from ignition detector probe on injector dome. On engines incorporating MD330 change, disconnect electrical connection (paragraph 3-30) P165 from combustion temperature probe on injector dome.

i. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, remove bolts that secure fuel probe line to ASI fuel manifold and thrust chamber. Remove seal. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, remove bolts and washers that secure ASI fuel line to lower fuel line flange. Remove seal.

j. Disconnect electrical connector (paragraph 3-30) P131 from temperature transducer on spark igniter fuel manifold. Remove transducer, and install clean protective closure (paragraph 3-258).

k. Cut the following instrumentation lines and protect all open ports: (Refer to section VI for tube cutting procedures.)

(1) Thrust chamber pressure line CG1.

(2) Thrust chamber pressure line CG1a.

(3) Main fuel injection pressure line CF2.

(4) Main oxidizer injection pressure line CO3.

l. Install clean protective closures (paragraph 3-258) on all open ports.

m. Remove start tank vent-and-relief valve as follows:

(1) Before removing start tank vent-and-relief valve, make sure start tank has been purged in accordance with R-3825-1B since last time fuel was introduced into system.

(2) Remove bolts, washers, and nuts that secure vent line bracket to support.

(3) Remove screw, washer, and nut that secure control line clamp to bracket.

(4) Remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank, and remove seal.

(5) Install clean protective closures (paragraph 3-258) on all open ports.

(6) Temporarily reposition and secure start tank vent-and-relief valve to provide access for removal of thrust chamber injector.

n. Loosen bolts that secure thrust chamber injector to thrust chamber, one turn.

o. Remove gimbal assembly as follows:

(1) Remove gimbal boot.

(2) Remove lockwire from 4 gimbal to oxidizer injector dome attaching bolts.

(3) If gimbal adjusting bolt and adjusting screw are safetywired to gimbal oxidizer injector dome attaching bolts, remove existing lockwire and safetywire bolt and screw to gimbal. Apply seal on screw and bolt lockwire.

CAUTION

If the gimbal adjusting bolt or screw is turned, the engine will require realinement.

(4) Scribe gimbal misalinement plate location (4 places) with respect to oxidizer injector dome. (See figure 3-28.) Paint surface to be scribed with machinist's blue ink, and scribe using a sharp metal scribe.

(5) Support gimbal, remove gimbal-to-dome attaching bolts and eccentric washers, and carefully remove gimbal from engine, making sure not to damage spark igniter cables.

(6) Install clean protective closures (paragraph 3-258) on gimbal.

p. Remove ASI as follows:

CAUTION

Removing the ASI without removing dirt and foreign matter from around the ASI injector can result in contamination of the thrust chamber injector.

(1) Remove all dirt and foreign matter from around ASI injector.

(2) Remove bolts and washers that secure ASI injector to thrust chamber injector dome. Remove ASI and seal, and install clean protective closures (paragraph 3-258) on ASI and thrust chamber oxidizer injector dome.

q. Loosen all bolts that secure injector to thrust chamber one turn; then remove all bolts and washers except one at the 12 o'clock position and one at the 6 o'clock position.

r. Attach suitable handling equipment to injector and connect to overhead hoist. Carefully take up slack in connecting equipment between hoist and injector until injector weight can be supported without binding during removal.

s. Remove bolts and washers from the 12 and 6 o'clock positions and install guide pins in these boltholes.

CAUTION

Binding between the injector and thrust chamber can cause damage to the thrust chamber and/or injector.

t. Carefully remove injector (213 pounds) from thrust chamber, manipulating hoist as required to prevent binding and provide support.

u. After injector is clear of thrust chamber, remove guide pins.

v. Install clean protective closures (paragraph 3-258) on all open ports.

3-297. REMOVING THRUST CHAMBER INJECTOR (UNSTACKED STAGE). The thrust chamber injector (figure 3-69) may be removed and reinstalled but not replaced without affecting engine calibration.

a. Obtain the following tools and equipment:

(1) Guide pins (2 required). (Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(2) Electrical interface support 9024460

(3) Fluid lines interface support 9020628

(4) Fluid level, 4-6 inches long

(5) Adapter T-5044412

(6) Support ST3950166RKL001

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove fuel inlet duct (paragraph 3-60) and oxidizer inlet duct (paragraph 3-220).

d. Remove purge control valve as follows: (See figure 3-62.)

(1) Cut purge inlet line. (Refer to section VI for tube cutting requirements.) Protect open lines.

(2) Cut the following lines aft of flange joint of oxidizer dome and thrust chamber; then protect open lines: (Refer to section VI for tube cutting requirements.)

(a) Purge control line

(b) Purge outlet line

(c) Overboard vent line

(3) Remove screws, washers, and nuts that secure igniter cable and clamps to purge control valve. (See figure 3-62.)

(4) Remove bolt, washer, nut, and clamp that secure purge control line.

(5) Remove bolts that secure purge control valve and bracket, and remove valve and bracket.

e. Remove oxidizer high-pressure duct (paragraph 3-209).

f. Disconnect electrical connectors (paragraph 3-30) P115 and P120.

g. Remove MOV (paragraph 3-187).

h. Measure pressure in igniter cables as outlined in R-3825-1B; then depressurize igniter cables by backing off pressurizing valve locknut (figure 3-11) 1/2 to 1 turn and depressing valve core.

i. Remove the 4 pressurizing valves, nuts, and washers from pressurizing bosses, and protect all open ports.

j. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG spark igniter cables and remove bracket.

k. Remove remaining bolts that attach GG spark igniter cables to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the cable connector is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

l. Remove GG SIC bell housing from ECA, pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

lA. Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping igniter cable movement to a minimum.

m. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support ST3950166RKL001 on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

mA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

n. Install protective closures (paragraph 3-258) GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

o. Temporarily secure cables to engine.

p. Disconnect electrical connector (paragraph 3-30) P1, P2, and P3.

q. Remove nut, washers, and screws from ASI SIC pressurizing tube support clamps.

r. Remove bolts that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the cable connector is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

s. Remove ASI SIC bell housing from ECA, pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

sA. Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

t. Install support ST3950166RKL001 on bell housing of ASI SIC NA5-27448 as follows: (Support is not required on ST3950166RKL001.)

(1) Place support ST3950166RKL001 on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

tA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

tB. Install protective closures on ASI SIC NA5-27448 support, or bell housing of SIC NA5-27448T1, and on ECA.

u. Remove SIC support clamps. Note position of clamps for reinstallation.

v. On engines not incorporating MD338 change, disconnect electrical connector (paragraph 3-30) P19 from ignition detector probe on injector dome. On engines incorporating MD330 change, disconnect electrical connector (paragraph 3-30) P165 from combustion temperature probe on injector dome.

w. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, cut lockwire and remove bolts and washers that secure fuel probe line to ASI fuel manifold and to thrust chamber. Remove seal and protect open ports and sealing surfaces. On engines incorporating MD327, MD328, MD332, or MD344 change, cut lockwire and remove bolts and washers that secure ASI fuel line to lower fuel line flange. Remove seal and protect open ports and sealing surfaces.

x. Disconnect electrical connector (paragraph 3-30) P131 from temperature transducer on ASI fuel manifold. Remove transducer and protect open ports and sealing surfaces.

y. Cut the following instrumentation lines and protect all open ports: (Refer to section VI for tube cutting requirements.)

(1) Main fuel injection pressure line (CF2).

(2) Main oxidizer injection pressure line (CO3).

(3) Thrust chamber pressure line (CG1).

(4) Thrust chamber pressure line (CG1a) (on engines not incorporating MD150 change).

WARNING

Removing start tank components before the system is depressurized can result in serious injury to personnel and damage to equipment.

- Removing components from a system containing gaseous hydrogen can cause an explosion, resulting in serious injury or death to personnel and damage to equipment.

z. Prior to removing start tank vent-and-relief valve, make sure system is depressurized and has been purged in accordance with purge procedures in R-3825-1B since last time fuel was introduced into system.

NOTE

Steps aa through ac outline start tank vent-and-relief valve removal.

aa. Remove bolts, washers, and nuts that secure vent line bracket to support.

ab. Remove screw, washer, and nut that secure control line clamp to bracket.

ac. Remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal, and protect open ports and sealing surfaces.

ad. Temporarily reposition and secure start tank vent-and-relief valve to provide vertical access for removal of thrust chamber injector.

ae. Install electrical and fluid lines interface supports on engine. Disconnect electrical and fluid interface lines from stage, and attach disconnected lines to interface supports.

af. Remove gimbal boot.

ag. Install suitable equipment to lower engine from which injector is to be removed. Engine must be lowered a maximum of 7 inches to remove injector.

ah. Make sure that engine is level and engine lowering equipment has been manually tightened (no slack). Use fluid level on oxidizer dome or dome bolts, to check level of engine.

ai. Remove bolts and washers that secure customer-connect tube support clevis to thrust chamber dome.

aj. Loosen bolts that secure thrust chamber injector to thrust chamber one turn.

ak. Make sure engine lowering equipment has been manually tightened then loosen hardware that secures gimbal to stage, and back off nuts 1/2 ±1/16 inch.

al. Slowly lower engine by extending lowering equipment until a 1/4 ±1/16 inch gap exists between stage and gimbal. Use fluid level in 2 planes, 90 degrees apart, while lowering, to maintain level of engine.

am. Remove nuts and bolts that formerly secure gimbal to stage.

NOTE

There will be some small side movement at the gimbal, the effect of which can be minimized by lowering slowly and carefully.

an. Slowly lower engine by extending engine lowering equipment until just prior to disengagement of gimbal keyway, at which time, reduce lowering rate until gimbal is clear. Monitor gimbal while lowering, for evidence of cocking or binding. Correct binding or cocking by straightening gimbal by hand or by pushing on engine around dome area.

ao. Lower engine a maximum of 7 inches. While lowering, keep engine reasonably level.

ap. Attach suitable handling equipment to thrust chamber injector (290 pounds).

aq. Remove bolts and washers that secure thrust chamber injector to thrust chamber.

ar. Install guide pins in thrust chamber-to-injector boltholes adjacent to lowering system attach points.

CAUTION

Binding between the injector and thrust chamber can cause damage to the thrust chamber and/or injector and add unnecessary loads to the hoisting equipment.

as. Using suitable handling equipment, lift thrust chamber injector (290 pounds) from thrust chamber. Keep lift vertical by coordinating lateral and/or longitudinal adjustments with vertical movements.

at. After thrust chamber injector is clear of thrust chamber, remove guide pins.

au. Temporarily remove safety cable attached to oxidizer turbopump support strut.

av. Using suitable handling equipment, move thrust chamber injector clear of engine.

aw. Reinstall safety cable to oxidizer turbopump support strut.

ax. Remove protective material from ports, sealing surfaces, and line ends, and install clean protective closures (paragraph 3-258).

3-298. REMOVING THRUST CHAMBER INJECTOR (STACKED SII STAGE). The thrust chamber injector (figure 3-69) may be removed and reinstalled but not replaced without affecting engine calibration.

a. Obtain the following equipment: (Items 2 through 7, and 11 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4071, shelf 2

(2) Engine component handler 9024539 from engine components installer set 9026251

(3) Engine component pickup adapter 9024547 from engine components installer set 9026251

(4) Chain-hoist 9027095 from engine components installer set 9026251

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Engine component hanger 9024543 from engine components installer set 9026251

(8) Component handling cart 9026253-11 from engine components installer set 9026251

(9) Guide pins (2 required). (Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(10) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(11) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(12) Torque wrench capable of torquing to 145-185 in-lb.

(13) Electrical interface support 9024460

(14) Fluid lines interface support 9020628

(15) Fluid level, 4-6 inches long.

(16) Single-Head Special Tool Kit G3127.

(17) Adapter T-5044412.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track (section V) around engine from which thrust chamber injector is to be removed. Install turntable and boom with controls leading, and position hoist at track station 13.5 for engine positions 1 through 4, or track station 20 for engine position 5.

d. Remove fuel inlet duct (paragraph 3-61) and oxidizer inlet duct (paragraph 3-221) for engine positions 1 through 4; for engine position 5, remove fuel and oxidizer inlet ducts using applicable Stage Contractor procedures.

e. Remove purge control valve as follows: (See figure 3-62.)

(1) Cut purge inlet line. (Refer to section VI for tube cutting requirements.) Protect open lines.

(2) Cut the following lines aft of flange joint of oxidizer dome and thrust chamber; then protect open lines: (Refer to section VI for tube cutting requirements.)

(a) Purge control line.

(b) Purge outlet line.

(c) Overboard vent line.

(3) Remove screws, washers, and nuts that secure igniter cable and clamps to purge control valve. (See figure 3-62.)

(4) Remove bolt, washer, nut, and clamp that secure purge control line.

(5) Remove bolts that secure purge control valve and bracket, and remove valve and bracket.

f. Remove oxidizer high-pressure duct (paragraph 3-210).

g. Disconnect electrical connectors (paragraph 3-30) P115 and P120.

h. Remove MOV (paragraph 3-187).

i. Measure pressure in SIC as outlined in R-3825-1B; then depressurize SIC by backing off pressurizing valve locknut (figure 3-11) 1/2 to 1 turn and depressing valve core.

j. Remove the 4 pressurizing valves, nuts, and washers from pressurizing bosses, and protect all open ports.

k. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG SIC and remove bracket.

l. Remove remaining bolts that attach GG SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the cable connector is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

m. Remove GG SIC bell housing from ECA, pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

mA. Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

n. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support ST3950166RKL001 on SIC bell housing, so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

nA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

o. Install protective closures on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

p. Temporarily secure cables to engine.

q. Disconnect electrical connectors (paragraph 3-30) P1, P2, and P3.

r. Remove nut, washers, and screws from ASI SIC pressurizing tube support clamps.

s. Remove bolts that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the cable connector is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

t. Remove ASI SIC bell housing from ECA, pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

tA. Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

u. Install support ST3950166RKL001 on bell housing of ASI SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support ST3950166RKL001 on SIC bell housing, so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

uA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

uB. Install protective closures (paragraph 3-258) on ASI SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

v. Remove SIC support clamps. Note position of clamps for reinstallation.

w. On engines not incorporating MD338 change, disconnect electrical connector (paragraph 3-30) P19 from ignition detector probe on injector dome. On engines incorporating MD330 change, disconnect electrical connector P165 from combustion temperature probe on injector dome.

x. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, cut lockwire and remove bolts and washers that secure fuel probe line to ASI fuel manifold and to thrust chamber. Remove seal. Protect open ports and sealing surfaces. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, cut lockwire and remove bolts and washers that secure ASI fuel line to lower fuel line flange. Remove seal. Protect open ports and sealing surfaces.

y. Disconnect electrical connector (paragraph 3-30) P131 from temperature transducer on ASI fuel manifold. Remove transducer, and protect open ports and sealing surfaces.

z. Cut the following instrumentation lines and protect all open ports: (Refer to section VI for tube cutting requirements.)

(1) Main fuel injector pressure line (CF2).

(2) Main oxidizer injection pressure line (CO3).

(3) Thrust chamber pressure line (CG1).

WARNING

Removing start tank components before the system is depressurized can result in serious injury to personnel and damage to equipment.

- Removing components from a system containing gaseous hydrogen can cause an explosion, resulting in serious injury or death to personnel and damage to equipment.

aa. Before removing start tank vent-and-relief valve, make sure system is depressurized and has been purged in accordance with purge procedures in R-3825-1B since last time fuel was introduced into system.

NOTE

Steps ab through ad outline start tank vent-and-relief valve removal.

ab. Remove bolts, washers, and nuts that secure vent line bracket to support.

ac. Remove screw, washer, and nut that secure control line clamp to bracket.

ad. Remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal, and protect open port and sealing surfaces.

ae. Temporarily reposition and secure start tank vent-and-relief valve to provide vertical access for removal of thrust chamber injector.

af. Install electrical and fluid lines interface supports on engine. Disconnect electrical and fluid interface lines from stage, and attach disconnected lines to interface supports.

ag. Remove gimbal boot.

ah. Install engine lowering system for engine from which injector is to be removed. (Refer to section V.) Engine must be lowered a maximum of 7 inches to remove injector.

ai. Adjust lower end of turnbuckles to position shown in figure 2-5.

aj. Make sure that engine is level in plane controlled by turnbuckles and that turnbuckles are manually tightened (no slack). Use fluid level on oxidizer dome or dome bolts, to check level of engine.

ak. Remove bolts and washers that secure customer-connect tube support clevis to thrust chamber dome.

al. Loosen bolts that secure thrust chamber injector to thrust chamber one turn.

CAUTION

While the weight of the engine is supported by the turnbuckles, the adjustments at the lower end of the turnbuckles must not be changed. Changing lower-end adjustment can induce moments into the turnbuckles that can bend and may break the turnbuckles.

am. Make sure lower end of turnbuckles are positioned to dimension shown in figure 2-5; then loosen hardware that secures gimbal to stage, and back off nuts 1/2 ±1/16 inch.

an. Slowly lower engine by extending turnbuckles until a 1/4 ±1/16 inch gap exists between stage and gimbal. Rotate turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other.

ao. Adjust mechanism at top of turnbuckles to position turnbuckles vertically in 2 planes, 90 degrees apart. Use fluid level.

ap. Remove nuts and bolts that formerly secured gimbal to stage.

NOTE

There will be some small side movement at the gimbal, the effect of which can be minimized by lowering slowly and carefully.

aq. Slowly lower engine by rotating turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other until just prior to disengagement of gimbal keyway, at which time, reduce rotation of turnbuckles to 1/6-turn increments until gimbal is clear. Monitor gimbal while lowering, for evidence of binding or cocking. Correct binding or cocking by straightening gimbal by hand or by pushing on engine around dome area.

NOTE

One flat of the turnbuckles adjusting barrel may be marked as an index to keep count of turnbuckle rotations.

ar. Lower engine a maximum of 7 inches by extending turnbuckles. While lowering, keep engine reasonably level by maintaining turnbuckles within one turn of each other.

as. Disassemble handler 9027263 by separating extension from handler. Attach extension to hoist, and straddle gimbal with handler as shown in figure 3-29. Handler is to be positioned to extend over engine between oxidizer dome inlet flange and oxidizer turbopump.

at. Loosen knobs that secure 4 tubes of handler and adjust tubes until tubes contact dome (with handler in approximately level position); then tighten knobs fingertight.

au. Attach hoist with extension (step as) to handler. Manipulate turntable and boom to effect as short a coupling between extension and handler portions of handler 9027263 as possible, and pin the 2 parts of handler together.

av. Remove bolts and washers that secure thrust chamber injector to thrust chamber.

aw. Install guide pins in thrust chamber-to-injector boltholes adjacent to lowering system attach points.

CAUTION

Binding between the injector and thrust chamber can cause damage to the thrust chamber and/or injector and add unnecessary loads to the hoisting equipment.

ax. Using hoist, lift thrust chamber injector (290 pounds) from thrust chamber. Keep lift vertical by coordinating lateral and/or longitudinal adjustment of turntable controls with hoist boom vertical controls.

ay. After thrust chamber injector is clear of thrust chamber, remove guide pins.

az. Temporarily remove safety cable attached to oxidizer turbopump support strut.

ba. Using hoist, move thrust chamber injector clear of engine.

bb. Reinstall safety cable to oxidizer turbopump support strut.

bc. Remove protective material from ports, sealing surfaces, and line ends, and install clean protective closures (paragraph 3-258).

NOTE

If the launch tower umbilical arm is to be used to transport the component from the stage, omit steps bd through bg.

bd. Install handler 9024539 on gimbal, and attach pickup adapter to handler eyebolt.

be. Using hoist, transfer gimbal and injector to hanger by attaching pickup adapter swivel to hanger with ball-lock pin.

bf. Remove handler 9027263 from hoist boom, and install chain-hoist to hoist boom.

bg. Attach hoist hook to pickup adapter using a shackle, and slowly raise the gimbal and injector.

bh. Using hoist, slowly move gimbal and injector through stage access door and lower into component handler cart.

bi. Maintain or note length of gimbal and injector handler for gimbal reinstallation.

3-299. REMOVING THRUST CHAMBER INJECTOR (STACKED SIVB STAGE). The thrust chamber injector (figure 3-69) may be removed and reinstalled but not replaced without affecting engine calibration. Engine Components Installer G4072MD2 must be used when performing this task.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment:

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4072, shelf 2

(2) Engine component handler 9024539 from Engine Components Installer G4072, shelf 3

(3) Engine component pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Engine component hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Chain-hoist 9027095 from engine components installer set 9026252

(6) Component handling cart 9026253-11 from engine components installer set 9026252

(7) Extension bar SX-24 from engine components installer set 9026252

(8) Universal joint S8 from engine components installer set 9026252

(9) Single-Head Special Tool Kit G3127

(10) Fluid level, 4-6 inches long.

(11) Adapter T-5044412.

(12) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc).

(13) Guide pins (2 required). (Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(14) Torque wrench capable of torquing to 145-185 in-lb.

(15) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026252 (required for use on launch tower umbilical arm).

(16) Electrical interface support 9024460.

(17) Fluid interface support 9020628.

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Assemble track (section V) for thrust chamber injector removal from SIVB stage. Install turntable with controls trailing.

d. Remove fuel inlet duct (paragraph 3-61) and oxidizer inlet duct (paragraph 3-221).

e. Remove purge control valve as follows: (See figure 3-62.)

(1) Cut purge inlet line. (Refer to section VI for tube cutting requirements.) Protect open lines.

(2) Cut the following lines aft of flange joint of oxidizer dome and thrust chamber; then protect open lines: (Refer to section VI for tube cutting requirements.)

(a) Purge control line.

(b) Purge outlet line.

(c) Overboard vent line.

(3) Remove screws, washers, and nuts that secure igniter cable and clamps to purge control valve. (See figure 3-62.)

(4) Remove bolt, washer, nut, and clamp that secure purge control line.

(5) Remove bolts that secure purge control valve and bracket, and remove valve and bracket.

f. Remove oxidizer high-pressure duct (paragraph 3-211).

g. Disconnect electrical connectors (paragraph 3-30) P115 and P120.

h. Remove MOV (paragraph 3-187).

i. Measure pressure in SIC as outlined in R-3825-1B; then depressurize SIC by backing off pressurizing valve locknut (figure 3-11) 1/2 to 1 turn, and depressing valve core.

j. Remove the 4 pressurizing valves, nuts, and washers from pressurizing bosses, and protect all open ports.

k. Remove bolts that secure pressurizing valve mounting bracket to bell housing of GG SIC and remove bracket.

l. Remove remaining bolts that attach GG SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the cable connector is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

m. Remove GG SIC bell housing from ECA, pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

mA. Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping igniter cable movement to a minimum.

n. Install support ST3950166RKL001 on bell housing of GG SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support ST3950166RKL001 on SIC bell housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

nA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not required.

o. Install protective closure (paragraph 3-258) on GG SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

p. Temporarily secure cables to engine.

q. Disconnect electrical connectors (paragraph 3-30) P1, P2, and P3.

r. Remove nut, washers, and screws from ASI SIC pressurizing tube support clamps.

s. Remove bolts that secure ASI SIC to ECA.

CAUTION

Tipping or side motion of the SIC bell housing before the cable connector is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the SIC or prying on bell housing can damage the SIC and ECA.
- Excessive bending and twisting of SIC can damage the cable bellows.
- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

t. Remove ASI SIC bell housing from ECA, pulling straight out until cable connector clears exciter output adapter. Use care to prevent damage to SIC and ECA.

tA. Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

u. Install support ST3950166RKL001 on bell housing of ASI SIC NA5-27448 as follows: (Support is not required on SIC NA5-27448T1.)

(1) Place support ST3950166RKL001 on SIC housing so that plastic plunger in support is seated in SIC connector. Install bolts and washers in counterbored holes in support.

(2) Tighten bolts until flange on support seats on SIC bell housing flange.

CAUTION

Incorrect installation of desiccant in SIC NA5-27448T1 protective closure can displace desiccant retainer, causing damage to the SIC connector.

uA. Make sure SIC closure desiccant is correctly installed and desiccant retainer in closure is not displaced.

uB. Install protective closure (paragraph 3-258) on ASI SIC NA5-27448 support or bell housing of SIC NA5-27448T1, and on ECA.

v. Remove SIC support clamps. Note position of clamps for reinstallation.

w. On engines not incorporating MD338 change, disconnect electrical connector (paragraph 3-30) P19 from ignition detector probe on injector dome. On engines incorporating MD330 change, disconnect electrical connector P165 from combustion temperature probe on injector dome.

x. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, cut lockwire and remove bolts and washers that secure fuel probe line to ASI fuel manifold and to thrust chamber. Remove seal. Protect open ports and sealing surfaces. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, cut lockwire and remove bolts and washers that secure ASI fuel line to lower fuel line flange. Remove seal. Protect open ports and sealing surfaces.

y. Disconnect electrical connector (paragraph 3-30) P131 from temperature transducer on ASI fuel manifold. Remove transducer, and protect open ports and sealing surfaces.

z. Cut the following instrumentation lines and protect all open ports: (Refer to section VI for tube cutting requirements.)

(1) Main fuel injection pressure line (CF2).

(2) Main oxidizer injection pressure line (CO3).

(3) Thrust chamber pressure line (CG1).

WARNING

Removing start tank components before the system is depressurized can result in serious injury to personnel and damage to equipment.

- Removing components from a system containing gaseous hydrogen can cause an explosion, resulting in serious injury or death to personnel and damage to equipment.

aa. Before removing start tank vent-and-relief valve, make sure system is depressurized and has been purged in accordance with purge

procedures in R-3825-1B since last time fuel was introduced into system.

NOTE

Steps ab through ad outline start tank vent-and-relief valve removal.

ab. Remove bolts, washers, and nuts that secure vent line bracket to support.

ac. Remove screw, washer, and nut that secure control line clamp to bracket.

ad. Remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal, and protect open ports and sealing surfaces.

ae. Temporarily reposition and secure start tank vent-and-relief valve to provide vertical access for removal of thrust chamber injector.

af. Install electrical and fluid lines interface supports on engine. Disconnect electrical and fluid interface lines from stage, and attach disconnected lines to interface supports.

ag. Remove gimbal boot.

ah. Install engine lowering system. (Refer to section V.) Engine must be lowered a maximum of 7 inches to remove injector.

ai. Adjust lower end of both turnbuckles to dimension shown in figure 2-5.

aj. Make sure that engine is level in plane controlled by turnbuckles and that turnbuckles are manually tightened (no slack). Use fluid level on oxidizer dome or dome bolts, to check level of engine.

ak. Remove bolts and washers that secure customer-connect tube support clevis to thrust chamber dome.

al. Loosen bolts that secure thrust chamber injector to thrust chamber one turn.

CAUTION

While the weight of the engine is supported by the turnbuckles, the adjustments at the lower end of the turnbuckles must not be changed. Changing the lower-end adjustment can induce moments into the turnbuckles that can bend and may break the turnbuckles.

am. Make sure lower end of turnbuckles are positioned to dimension shown in figure 2-5; then loosen hardware that secure gimbal to stage, and back off nuts 1/2 ±1/16 inch.

an. Slowly lower engine by extending turnbuckles until a 1/4 ±1/16 inch gap exists between stage and gimbal. Rotate turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other.

ao. Adjust mechanism at top of turnbuckles to position turnbuckles vertically in 2 planes, 90 degrees apart. Use fluid level.

ap. Remove nuts and bolts that formerly secured gimbal to stage.

NOTE

There will be some small side movement at the gimbal, the effect of which can be minimized by lowering the engine slowly and carefully.

aq. Slowly lower engine by rotating turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other until just prior to disengagement of gimbal keyway, at which time, reduce rotation of turnbuckles to 1/6-turn increments until gimbal is clear. Monitor gimbal while lowering, for evidence by binding or cocking. Correct binding or cocking by straightening gimbal by hand or by pushing on engine around dome area.

NOTE

One flat of turnbuckles adjusting barrel may be marked as an index to keep count of turnbuckle rotations.

ar. Lower engine a maximum of 7 inches by extending turnbuckles. While lowering, keep engine reasonably level by maintaining turnbuckles within one turn of each other.

as. Attach handler to hoist and extend adapter to 6th positioning hole. Secure with ball-lock pin. Yoke of handler is to be horizontal with side of yoke that contains sliding plate up.

at. Manipulate hoist and straddle gimbal with adapter as shown in figure 3-29. Handler position is to be over engine, between oxidizer inlet flange and oxidizer turbopump.

au. Loosen knobs that secure 4 tubes of handler, and adjust tubes until tubes contact dome (with handler in approximately level position); then tighten knobs fingertight.

av. Remove bolts and washers that secure thrust chamber injector to thrust chamber.

aw. Install guide pins in thrust chamber-to-injector boltholes adjacent to lowering system attach points.

CAUTION

Binding between the injector and thrust chamber can cause damage to the thrust chamber and/or injector and add unnecessary loads to the hoisting equipment.

ax. Using hoist, lift thrust chamber injector (290 pounds) from thrust chamber. Keep lift vertical by coordinating lateral and/or longitudinal adjustment of turntable controls with hoist boom vertical controls.

ay. After thrust chamber injector is clear of thrust chamber, remove guide pins.

az. Temporarily remove safety cable attached to oxidizer turbopump support strut.

ba. Using hoist, move thrust chamber injector clear of engine.

bb. Reinstall safety cable to oxidizer turbopump support strut.

bc. Remove protective material from ports, sealing surfaces, and line ends, and install clean protective closure (paragraph 3-258).

bd. Assemble hanger, and place hanger in area that will be accessible to both lower and elevated track. (See appropriate track configuration figure in section V.)

be. Using hoist, move thrust chamber injector to hanger.

bf. Install engine component handler 9024539 on gimbal. Torque bolts to 145-185 in-lb.

bg. Install pickup adapter on hanger and secure with ball-lock pin.

bh. Raise thrust chamber injector until engine component handler engages pickup adapter. Secure with ball-lock pin.

bi. Remove hoist and handler 9027263 from thrust chamber injector.

bj. Assemble elevated track. (Refer to section V.)

bk. Install chain-hoist on hoist and secure with ball-lock pin.

bl. Install shackle on pickup adapter. Do not install shackle in pickup adapter slot.

bm. Move hoist into position to pick up thrust chamber injector.

bn. Connect chain-hoist chain to shackle.

bo. Using hoist and chain-hoist, remove thrust chamber injector from hanger.

CAUTION

The thrust chamber injector must be restrained due to the limited access, to prevent damage to the thrust chamber injector and stage.

bp. Using hoist, move thrust chamber injector through stage access door. Manually restrain movement of thrust chamber injector when moving it through stage access door.

bq. Place a clean sheet of polyethylene on floor of component handling cart, and using chain-hoist and hoist, lower thrust chamber injector into cart.

br. Remove ball-lock pin that secures pick-up adapter to engine component handler. Remove engine component handler from gimbal.

3-300. INSTALLING THRUST CHAMBER INJECTOR (ENGINE HANDLER). The thrust chamber injector (figure 3-69) may be reinstalled but not replaced without affecting engine calibration.

a. Obtain the following equipment and materials:

(1) Suitable equipment to support injector (213 pounds) during installation in engine in the horizontal position.

(2) Guide pins (2 required). Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(3) Adapter T-5044412.

(4) Torque wrenches capable of torquing 6-126 in-lb, 145-630 in-lb, and 725-775 in-lb.

(5) Molykote Z powder (Dow Corning Corp).

(6) Sealing and antiseize compound RB0140-005 (Rocketdyne).

(7) FS1281 grease (Dow Corning Corp).

(8) Blue-tinted lacquer ST0125RB0003 (Rocketdyne).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Attach suitable handling equipment to lift and support injector (213 pounds) in correct position during installation.

d. Using hoist, position injector for installation in thrust chamber.

e. Remove protective closures (paragraph 3-257) from face of injector and thrust chamber. Make sure injector, mating surfaces of thrust chamber, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

f. Install inner thrust chamber injector to thrust chamber metal O-ring seal on thrust chamber injector.

g. Place thrust chamber injector to thrust chamber pressure-actuated seal on injector, and aline holes in seal with injector boltholes. Install 2 guide pins, one in the 12 o'clock position and one in the 6 o'clock position, through injector boltholes and pressure-actuated-seal holes into thrust chamber.

CAUTION

Binding between the injector and thrust chamber during installation can cause damage to the injector and/or thrust chamber.

h. Carefully mate injector to thrust chamber making sure seals remain in position.

i. Remove guide pins. Lubricate (Method V, section I) both sides of washers with Molykote Z powder (Dow Corning Corp); then install bolts and washers that secure injector to thrust chamber, and tighten bolts fingertight. On engines using thrust chamber assembly 206606-101, -111, -121, -131, -141, -151, or -161, install bolt RD111-4020-3819 in location shown in figure 3-69.

j. Remove handling equipment and cross-torque injector to thrust chamber bolts to 725-775 in-lb and safetywire.

k. Remove protective closures (paragraph 3-257) from injector, and mating surface of ASI. Make sure ASI, mating surface of injector, threads in parent metal, and/or threaded inserts are free of damage, and threaded inserts are installed correctly (section I).

l. Install ASI (paragraph 3-10).

m. Remove protective material from tube ends and weld the following instrumentation lines: (Refer to section VI for welding requirements.)

(1) Thrust chamber pressure CG1

(2) Thrust chamber pressure CG1a

(3) Main fuel injection pressure CF2

(4) Main oxidizer injection pressure CO3

n. Make sure gimbal assembly and ASI mating surfaces, threads in parent metal, and/or threaded inserts are free of damage, and threaded inserts are installed correctly (section I).

o. Install gimbal (paragraph 3-116).

p. Install start tank vent-and-relief valve as follows: (See figure 3-68.)

(1) Remove protective closures (paragraph 3-257), and make sure mating surfaces of vent-and-relief valve, threads in parent metal, and/or threaded inserts are free of damage, and threaded inserts are installed correctly (section I).

(2) Position valve and seal on start tank flange and secure with bolts and washers. Torque bolts to 114-126 in-lb and safetywire.

(3) Install bolts, washers, and nuts that secure vent line bracket to support. Torque bolts to 20-25 in-lb.

(4) Install bolts, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 in-lb.

q. On engines not incorporating MD150 or MD192 change, weld ASI pressure instrumentation line. (Refer to section VI for tube welding requirements.)

r. On engines not incorporating MD338 change, connect electrical connector (paragraph 3-31) P19 to ignition detector probe on injector dome. On engines incorporating MD330 change, connect electrical connector (paragraph 3-31) P165 to combustion temperature probe on injector dome.

s. Install ASI fuel line as follows:

(1) Install seal between ASI fuel line and lower fuel line.

(2) Check alinement of mating holes in ASI line flange with mating holes in lower fuel line flange. Holes must aline within ±0.125 inch.

(3) Measure gap between ASI line and lower fuel line flange. Gap must be within 0.025 to 0.275 inch.

(4) Apply hand-pressure to ASI line flange until seal contacts mating surface of lower fuel line flange. Mating surfaces must be parallel within 0.025 inch.

(5) Apply hand-pressure to ASI line flange until seal contacts mating surface of lower fuel line flange. If all bolts can be installed without forcing, rotational alinement is acceptable.

CAUTION

The fuel line must be supported, to prevent excessive loads on the weld near the ASI injector when making alinement bends.

(6) If fuel line does not fall within tolerances of substeps 2 through 5, bend fuel line to meet alinement requirements. Use an approved tube-bending tool, and support the fuel line to prevent movement during alinement bending. Bends must not be made within 3 inches of any tube weld.

(7) Install seal, bolts, washers, and bracket on fuel line flange. Torque bolts to 40-55 in-lb.

t. Install temperature transducer and seal on spark igniter fuel manifold. Torque bolts to 48-53 in-lb and safetywire.

u. Connect electrical connector (paragraph 3-31) P131.

NOTE

To prevent corrosion, steps v through am must be completed within 24 hours.

v. Using abrasive cloth, remove protective finishes and foreign matter from 4 attaching bolts and area around 4 mating holes, 90 degrees apart, on each SIC bell housing flange. Clean bonding surfaces of SIC bell housing and mating surfaces without damaging sealing surfaces.

w. Lubricate (Method A, section I) bolts that attach ASI cable to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

x. Lubricate (Method J, section I) ASI cable O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from antirotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

y. Install ASI SIC on ECA and secure with bolts. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

z. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire. To minimize the need to disassemble due to ASI SIC leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedures.)

aa. Install support clamps on ASI SIC pressurizing tubes with bolts, washers, and nuts. Torque nuts to 33-42 in-lb.

ab. Connect electrical connectors (paragraph 3-31) P1, P2, and P3.

ac. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

ad. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

ae. Install GG SIC on ECA with 2 bolts. Tighten bolts fingertight.

af. Position bracket on SIC pressurizing tube bosses and secure bracket and SIC bell housing to ECA with bolts. Tighten bolts fingertight.

ag. Install remaining bolts in SIC bell housing. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

ah. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire.

ai. Install washers and nuts on SIC pressurizing tube bosses; torque nuts to 290 ±10 in-lb and safetywire.

aj. (Deleted)

ak. Install pressurizing valves in pressurizing tube bosses. (Refer to paragraph 3-245C.)

al. Measure resistance from ECA to thrust chamber ground cable and from each SIC bell housing to thrust chamber. Resistance from each bell housing to thrust chamber must not exceed 100 milliohms above resistance from ECA to thrust chamber ground cable.

am. Apply a coating of blue-tinted lacquer to ST0125RB0003 (Rocketdyne to all bonding connections.

an. Leak-test and pressurize SIC. (Refer to (R-3825-1B.)

ao. Install MOV (paragraph 3-188).

ap. Install oxidizer high-pressure duct paragraph 3-212).

aq. Install purge control valve (paragraph 3-261).

ar. Refer to section IV for test requirements.

3-301. INSTALLING THRUST CHAMBER INJECTOR (UNSTACKED STAGE). The thrust chamber injector (figure 3-69) may be removed and reinstalled but not replaced without affecting engine calibration.

a. Obtain the following tools, equipment and materials:

(1) Guide pins (2 required). (Make from bolts RD111-4009-6860 or RD111-4009-6862, or equivalent.)

(2) Electrical interface support 9024460.

(3) Fluid lines interface support 9020628.

(4) Fluid level, 4-6 inches long.

(5) Adapter T-5044412.

(6) Molykote Z powder (Dow Corning Corp).

(7) Sealing and antiseize compound RB0140-005 (Rocketdyne).

(8) FS1281 grease (Dow Corning Corp).

(9) Blue-tinted lacquer ST0125RB0003 (Rocketdyne).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure thrust chamber injector, engine mating surfaces, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Install suitable handling equipment to lift gimbal and injector (290 pounds).

e. Remove protective material and install inner thrust chamber injector to thrust chamber metal O-ring seal on thrust chamber injector.

f. Remove protective material and place thrust chamber injector to thrust chamber pressure-actuated seal on thrust chamber mating flange.

g. Temporarily remove safety cable attached to oxidizer turbopump support strut.

CAUTION

Care must be taken when positioning the thrust chamber injector over the engine not to damage the pressure-actuated seal.

h. Using suitable handling equipment, place gimbal and thrust chamber injector (290 pounds) into position over engine by passing gimbal and injector between oxidizer turbopump and MOV.

i. Reinstall safety cable to oxidizer turbopump support strut.

j. Install the 2 guide pins 180 degrees apart through thrust chamber injector boltholes and pressure-actuated seal holes into thrust chamber.

CAUTION

Binding between the thrust chamber injector and thrust chamber during installation can cause damage to the thrust chamber injector and/or thrust chamber.

k. Using suitable handling equipment, lower thrust chamber injector into place on thrust chamber.

l. Remove guide pins and handler.

m. Lubricate (Method V, section I) both sides of washers with Molykote Z powder (Dow Corning Corp); then install bolts and washers that secure thrust chamber injector to thrust chamber, fingertight.

n. Raise engine by use of engine lowering equipment until gimbal is about to engage stage. Keep engine reasonably level during raising operation.

o. Check that gimbal alines with stage. If there exists some small misalinement in the x- and z-axes, it can be compensated for by pushing on the engine about the dome area. If however, there is gross misalinement, level engine and/or aline gimbal to stage before proceeding.

p. With gimbal alined, raise engine in small increments until both keyways are engaged.

q. Continue raising engine carefully until gimbal is fully engaged (less than 0.030-inch gap) with stage. Adjust engine lowering equipment carefully to prevent binding between gimbal and stage.

r. Secure gimbal to stage using applicable stage procedures.

CAUTION

The thrust chamber can be damaged by striking the GSE or stage structure.

s. Cross-torque thrust chamber injector-to-thrust chamber bolts to 750 ±25 in-lb. Restrain engine while torquing bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be accomplished because of interference with engine lowering system, make sure bolts are seated, remove engine lowering system (step u), and then torque bolts.

t. Install bolts and washers to secure customer-connect tube support clevis to thrust chamber dome. Torque bolts to 750 ±25 in-lb.

u. Remove engine lowering system. (Refer to section V.)

v. Connect gimbal hydraulic actuators to engine attach points using applicable stage procedures.

w. Install gimbal boot. Torque clamp bolts to 6-8 in-lb.

NOTE

Steps x through z, outline start tank vent-and-relief valve installation.

x. Remove protective material, position valve and seal on tank flange, and secure with bolts and washers. Torque bolts to 114-126 in-lb and safetywire. (See figure 3-68.)

y. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 in-lb.

z. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 in-lb.

aa. Connect electrical connector (paragraph 3-31) P165 to combustion temperature probe on injector dome.

ab. Install ASI fuel line as follows:

(1) Remove protective material and install seal between ASI fuel line and lower fuel line.

(2) Check alinement of mating holes in ASI line flange with mating holes in lower fuel line flange. Holes must aline within ±0.125 inch.

(3) Measure gap between ASI line and lower fuel line flange. Gap must be within 0.025 to 0.275 inch.

(4) Apply hand-pressure to ASI line flange until seal contacts mating surface of lower fuel line flange. Mating surfaces must be parallel within 0.025 inch.

(5) Apply hand-pressure to ASI line flange until seal contacts mating surface of lower fuel line flange. If all bolts can be installed without forcing, rotational alinement is acceptable.

CAUTION

The fuel line must be supported to prevent excessive loads on the weld near the ASI injector when making alinement bends.

(6) If fuel line does not fall within tolerances of substeps 2 through 5, bend fuel line to meet alinement requirements. Use an approved tube-bending tool, and support the fuel line to prevent movement during alinement bending. Bend must not be made within 3 inches of any tube weld.

(7) Remove protective material and install seal, bolts, washers, and bracket on fuel line flange. Torque bolts to 40-55 in-lb.

abA. Remove protective material from tube ends and weld the following instrumentation lines: (Refer to section VI for welding requirements.)

(1) Main fuel injection pressure line (CF2)

(2) Main oxidizer injection pressure line (CO3)

(3) Thrust chamber pressure line (CG1)

(4) Thrust chamber pressure line (CG1a) (on engines not incorporating MD150 change)

ac. Remove protective material and install temperature transducer and seal on spark igniter fuel manifold. Torque bolts to 48-53 in-lb and safetywire.

ad. Connect electrical connector (paragraph 3-31) P131.

NOTE

To prevent corrosion, steps ae through av must be completed within 24 hours.

ae. Using abrasive cloth, remove protective finishes and foreign matter from 4 attaching bolts and area around 4 mating holes, 90 degrees apart, on each SIC bell housing flange. Clean bonding surfaces of SIC bell housing and mating surfaces without damaging sealing surfaces.

af. Lubricate (Method A, section I) bolts that attach ASI cable to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

ag. Lubricate (Method J, section I) ASI cable O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

ah. Install ASI SIC on ECA and secure with bolts. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

ai. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire. To minimize the need to disassemble due to ASI SIC leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedures.)

aj. Install support clamps on ASI SIC pressurizing tubes with bolts, washers, and nuts. Torque nuts to 33-42 in-lb.

ak. Connect electrical connectors (paragraph 3-31) P1, P2, and P3.

al. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

am. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

an. Install GG SIC on ECA with 2 bolts. Tighten bolts fingertight.

ao. Position bracket on SIC pressurizing tube bosses, and secure bracket and SIC bell housing to ECA with bolts. Tighten bolts fingertight.

ap. Install remaining bolts in SIC bell housing. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

aq. Cross-Torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire.

ar. Install washers and nuts on SIC pressurizing tube bosses; torque nuts to 290 ±10 in-lb and safetywire.

as. (Deleted)

at. Install pressurizing valves in pressurizing tube bosses. (Refer to paragraph 3-245C.)

au. Measure resistance from ECA to thrust chamber ground cable and from each SIC bell housing to thrust chamber. Resistance from each bell housing to thrust chamber must not exceed 100 milliohms above resistance from ECA to thrust chamber ground cable.

av. Apply a coating of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to all bonding connections.

aw. Leak-test and pressurize SIC. (Refer to R-3825-1B.)

ax. Install MOV (paragraph 3-188).

ay. Install oxidizer high-pressure duct (paragraph 3-213).

az. Install purge control valve as follows:

(1) Install purge control valve and bracket on flange of oxidizer high-pressure duct with bolts. Torque bolts to 570-630 in-lb and safetywire.

(2) Weld the following lines: (See figure 3-62. Refer to section VI for welding requirements.)

(a) Overboard vent line

(b) Purge outlet line

(c) Purge control line

(d) Purge inlet line

(3) Install support clamps that secure purge control line and igniter cable to purge control valve.

ba. Install fuel inlet duct (paragraph 3-65) and oxidizer inlet duct (paragraph 3-225).

bb. Connect electrical and fluid interface lines in accordance with applicable stage procedures, and remove electrical and fluid interface supports.

bc. Refer to section IV for test requirements.

3-302. INSTALLING THRUST CHAMBER INJECTOR (STACKED SII STAGE). The thrust chamber injector (figure 3-69) may be removed and reinstalled but not replaced without affecting engine calibration.

a. Obtain the following tools, equipment, and materials: (Items 9 through 14, and 18 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4071, shelf 2

(2) Fluid level, 4-6 inches long

(3) Automatic Inert Gas Arc Welding Set G3128

(4) Single-Head Special Tool Kit G3127

(5) Torque wrench capable of torquing to 6-126 in-lb

(6) Torque wrench capable of torquing to 145-630 in-lb

(7) Torque wrench capable of torquing to 725-775 in-lb

(8) Adapter T-5044412

(9) Engine component handler 9024539 from engine components installer set 9026251

(10) Engine component pickup adapter 9024547 from engine components installer set 9026251

(11) Chain-hoist 9027095 from engine components installer set 9026251

(12) Universal joint S8 from engine components installer set 9026251

(13) Extension bar SX-24 from engine components installer set 9026251

(14) Engine component hanger 9024543 from engine components installer set 9026251

(15) Component handling cart 9026253-11 from engine components installer set 9026251

(16) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026251 (required for use on launch tower umbilical arm)

(17) Guide pins (2 required). Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(18) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(19) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(20) Sealing and antiseize compound RB0140-005 (Rocketdyne)

(21) Abrasive cloth, 320-grit or finer

(22) FS1281 grease (Dow Corning Corp).

(23) Molykote Z powder (Dow Corning Corp).

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure thrust chamber injector, engine mating surfaces, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

NOTE

If the launch tower umbilical arm is to be used to transport the component to the stage, omit steps d through k.

d. Install handler 9024539 on gimbal, and attach pickup adapter to handler eyebolt. Torque bolts to 145-185 in-lb.

e. Install chain-hoist on hoist boom and extend hoist boom through stage access door.

f. Lower hoist hook and attach to pickup adapter, using shackle.

g. Using hoist and chain-hoist, raise injector (290 pounds), and transfer injector through stage access door, and attach gimbal and injector to hanger with pickup adapter swivel and ball-lock pin.

h. Remove chain-hoist from hoist boom.

i. Secure gimbal and thrust chamber injector in handler 9027263 as shown in figure 3-29.

j. Connect hoist to handler 9027263.

k. Using hoist, lift gimbal and injector from hanger. If installed, remove handler 9024539 and pickup adapter from gimbal.

l. Remove protective material and install inner thrust chamber injector to thrust chamber metal O-ring seal on thrust chamber injector.

m. Remove protective material and place thrust chamber injector to thrust chamber pressure-actuated seal on thrust chamber mating flange.

n. Temporarily remove safety cable attached to oxidizer turbopump support strut.

CAUTION

Care must be taken when positioning the thrust chamber injector over the engine not to damage the pressure-actuated seal.

o. Using hoist, place gimbal and thrust chamber injector (290 pounds) into position over engine by passing gimbal and injector between oxidizer turbopump and MOV while working hoist toward track station 13.5 for engine positions 1 through 4, or track station 20 for engine position 5.

p. Reinstall safety cable to oxidizer turbopump support strut.

q. Install the 2 guide pins 180 degrees apart through thrust chamber injector boltholes and pressure-actuated-seal holes into thrust chamber.

CAUTION

Binding between the thrust chamber injector and thrust chamber during installation can cause damage to the thrust chamber injector and/or thrust chamber.

r. Using hoist, lower thrust chamber injector into place on thrust chamber.

s. Remove guide pins and handler.

t. Lubricate (Method V, section I) both sides of washers with Molykote Z powder (Dow Corning Corp); then install bolts and washers that secure thrust chamber injector to thrust chamber, fingertight.

u. Raise engine by shortening turnbuckles until gimbal is about to engage stage. Keep engine reasonably level while raising by maintaining rotation of turnbuckles within one turn of each other.

v. Check that gimbal alines with stage. If there exists some small misalinement in the x- and z-axes, it can be compensated for by pushing on the engine about the dome area. If, however, there is gross misalinement, level engine and/or aline gimbal to stage by one or more of the following methods:

(1) Level engine by adjusting length of turnbuckles.

(2) If engine is level and gimbal does not aline, move engine in direction to aline gimbal to stage by use of adjustment mechanisms at top of turnbuckles. Adjust turnbuckles equally so that turnbuckles remain parallel to each other.

w. With gimbal alined, raise engine with 1/6-turn increments on turnbuckles until both keyways are engaged.

x. Continue raising engine by shortening turnbuckles until gimbal is fully engaged (less than 0.030-inch gap) with stage. To aid in prevention of binding between gimbal and stage, keep rotation of turnbuckles within one turn of each other.

y. Secure gimbal to stage using applicable stage procedures.

CAUTION

The thrust chamber can be damaged by striking the GSE or stage structure.

z. Cross-torque thrust chamber injector to thrust chamber bolts to 750 ±25 in-lb. Restrain engine while torquing bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be accomplished because of interference with engine lowering system, make sure bolts are seated, remove engine lowering system (step ab), and then torque bolts.

aa. Install bolts and washers to secure customer-connect tube support clevis to thrust chamber dome. Torque bolts to 750 ±25 in-lb.

ab. Remove engine lowering system. (Refer to section V.)

ac. Connect gimbal hydraulic actuators to engine attach points using applicable stage procedures.

ad. Disassemble track. (Refer to section V.)

ae. Install gimbal boot. Torque clamp bolts to 6-8 in-lb.

NOTE

Steps af through ah outline start tank vent-and-relief valve installation.

af. Remove protective material, position valve and seal on tank flange, and secure with bolts and washers. Torque bolts to 114-126 in-lb and safetywire. (See figure 3-68.)

ag. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 in-lb.

ah. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 in-lb.

ai. Remove protective material from tube ends and weld the following instrumentation lines: (Refer to section VI for welding requirements.)

(1) Main fuel injection pressure line (CF2)

(2) Main oxidizer injection pressure line (CO3)

(3) Thrust chamber pressure line (CG1)

aj. On engines not incorporating MD338 change, connect electrical connector (paragraph 3-31) P19 to ignition detector probe on injector dome. On engines incorporating MD330 change, connect electrical connector (paragraph 3-31) P165 to combustion temperature probe on injector dome.

ak. On engines not incorporating MD327, MD328, MD329, or MD344 change, install ASI fuel lines as follows:

(1) Install bolts and washers to secure fuel manifold to thrust chamber. Torque bolts to 62-68 in-lb and safetywire.

(2) Remove protective material and install seal, bolts, and washers to secure fuel probe line to ASI fuel manifold. Torque bolts to 52-58 in-lb and safetywire.

al. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, install ASI fuel line as follows:

(1) Remove protective material and install seal between ASI fuel line and lower fuel line.

(2) Check alinement of mating holes in ASI line flange with mating holes in lower fuel line flange. Holes must aline within ±0.125 inch.

(3) Measure gap between ASI line and lower fuel line flange. Gap must be within 0.025 to 0.275 inch.

(4) Apply hand-pressure to ASI line flange until seal contacts mating surface of lower fuel line flange. Mating surfaces must be parallel within 0.025 inch.

(5) Apply hand-pressure to ASI line flange until seal contacts mating surface of lower fuel line flange. If all bolts can be installed without forcing, rotational alinement is acceptable.

CAUTION

The fuel line must be supported to prevent excessive loads on the weld near the ASI injector when making alinement bends.

(6) If fuel line does not fall within tolerances of substeps 2 through 5, bend fuel line to meet alinement requirements. Use an approved tube-bending tool, and support fuel line to prevent movement during alinement bending. Do not make bends within 3 inches of any tube weld.

(7) Remove protective material and install seal, bolts, washers, and bracket on fuel line flange. Torque bolts to 40-55 in-lb.

am. Remove protective material and install temperature transducer and seal on spark igniter fuel manifold. Torque bolts to 48-53 in-lb and safetywire.

an. Connect electrical connector (paragraph 3-31) P131.

NOTE

To prevent corrosion, steps ao through bf must be completed within 24 hours.

ao. Using abrasive cloth, remove protective finishes and foreign matter from 4 attaching bolts and area around 4 mating holes, 90 degrees apart, on each SIC bell housing flange. Clean bonding surfaces of SIC housing and mating surfaces without damaging sealing surfaces.

ap. Lubricate (Method A, section I) bolts that attach ASI cable to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

aq. Lubricate (Method J, section I) ASI cable O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

ar. Install ASI SIC on ECA and secure with bolts. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

as. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire. To minimize the need to disassemble due to ASI SIC leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedures.)

at. Install support clamps on ASI SIC pressurizing tubes with bolts, washers, and nuts. Torque nuts to 33-42 in-lb.

au. Connect electrical connectors (paragraph 3-31) P1, P2, and P3.

av. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

aw. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

ax. Install GG SIC on ECA with 2 bolts. Tighten bolts fingertight.

ay. Position bracket on igniter cable pressurizing tube bosses and secure bracket and igniter cable bell housing to ECA with bolts. Tighten bolts fingertight.

az. Install remaining bolts in igniter cable bell housing. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

ba. Cross-torque bolts that secure igniter cables to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire.

bb. Install washers and nuts on igniter cable pressurizing tube bosses; torque nuts to 290 ±10 in-lb and safetywire.

bc. (Deleted)

bd. Install pressurizing valves in pressurizing tube bosses. (Refer to paragraph 3-245C.)

be. Measure resistance from ECA to thrust chamber ground cable and from each igniter cable bell housing to thrust chamber. Resistance from each bell housing to thrust chamber must not exceed 100 milliohms above resistance from ECA to thrust chamber ground cable.

bf. Apply a coating of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to all bonding bolts and connections.

bg. Leak-test and pressurize igniter cables. (Refer to R-3825-1B.)

bh. Install MOV (paragraph 3-188).

bi. Install oxidizer high-pressure duct (paragraph 3-213).

bj. Install purge control valve as follows:

(1) Install purge control valve and bracket on flange of oxidizer high-pressure duct with bolts. Torque bolts to 570-630 in-lb and safetywire.

(2) Weld the following lines: (See figure 3-62. Refer to section VI for welding requirements.)

(a) Overboard vent line.

(b) Purge outlet line.

(c) Purge control line.

(d) Purge inlet line.

(3) Install support clamps that secure purge control line and igniter cable to purge control valve.

bk. Install fuel inlet duct (paragraph 3-65) and oxidizer inlet duct (paragraph 3-225) for engine position 1 through 4; install ducts in accordance with applicable stage procedures for engine position 5.

bl. Connect electrical and fluid interface lines in accordance with applicable stage procedures, and remove electrical and fluid interface supports.

bm. Refer to section IV for test requirements.

3-303. INSTALLING THRUST CHAMBER INJECTOR (STACKED SIVB STAGE). The thrust chamber injector (figure 3-69) may be removed and reinstalled but not replaced without affecting engine calibration. Engine Components Installer G4072MD2 must be used when performing this task.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Obtain the following equipment and materials:

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4072, shelf 2.

(2) Engine component handler 9024539 from Engine Components Installer G4072, shelf 3.

(3) Engine component pickup adapter 9024547 from Engine Components Installer G4072, shelf 3.

(4) Engine component hanger 9024543 from Engine Components Installer G4072, shelf 2.

(5) Chain-hoist 9027095 from engine components installer set 9026252

(6) Component handling cart 9026253-11 from engine components installer set 9026252

(7) Universal joint S8 from engine components installer set 9026252

(8) Extension bar SX-24 from engine components installer set 9026252

(9) Automatic Inert Gas Arc Welding Set G3128

(10) Single-Head Special Tool Kit G3127

(11) Fluid level, 4-6 inches long

(12) Torque wrench capable of torquing to 6-126 in-lb

(13) Torque wrench capable of torquing to 145-630 in-lb

(14) Torque wrench capable of torquing to 725-775 in-lb

(15) Adapter T-5044412

(16) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(17) Blue-tinted lacquer ST0125RB0003 (Rocketdyne).

(18) Sealing compound RB0140-005 (Rocketdyne)

(19) Abrasive cloth, 320-grit or finer

(20) FS1281 grease (Dow Corning Corp)

(21) Ramp 9026255 (2 required) and 9026255-11 from engine components installer set 9026252 (required for use on launch tower umbilical arm)

(22) Guide pins (2 required). Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(23) Molykote Z powder (Dow Corning Corp)

b. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

c. Remove protective closures (paragraph 3-257). Make sure thrust chamber injector, engine mating surfaces, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

d. Install handler 9024539 on gimbal. Torque bolts to 145-185 in-lb.

e. Install pickup adapter on handler 9024539. Secure with ball-lock pin.

f. Install shackle on pickup adapter. Do not install shackle in pickup adapter slot.

g. Install chain-hoist on hoist and secure with ball-lock pin.

h. Attach chain-hoist chain to shackle.

i. Using hoist and chain-hoist, raise thrust chamber injector from cart.

CAUTION

The thrust chamber injector must be restrained due to the limited access, to prevent damage to the thrust chamber injector and stage.

j. Using hoist, move thrust chamber injector (290 pounds) into stage and to hanger. Manually restrain movement of thrust chamber injector when moving it through stage access door.

k. Lower injector to hanger and engage pickup adapter to hanger. Secure with ball-lock pin.

l. Disconnect chain from shackle, and remove chain-hoist from hoist, and shackle from pickup adapter.

m. Disassemble elevated track, and reassemble lower track. (Refer to section V.)

n. Attach gimbal and injector handler to hoist and extend handler adapter to 6th positioning hole. Secure with ball-lock pin.

o. Using hoist, install gimbal and injector handler on gimbal. (See figure 3-29.) Handler is to be positioned to extend over engine between oxidizer inlet flange and ASI oxidizer propellant line.

p. Using hoist, raise thrust chamber injector. Remove ball-lock pin that attaches pickup adapter to handler 9024539.

q. Remove handler 9024539 from gimbal.

r. Using hoist, move thrust chamber injector to engine position. Position hoist at track station.

s. Remove safety cable attached at oxidizer turbopump strut (figure 5-47) to allow thrust chamber injector to be moved into position.

t. Using hoist, move thrust chamber injector (290 pounds) into position above thrust chamber by passing it over engine between oxidizer turbopump and MOV.

u. Install safety cable removed in step s.

v. Install guide pins in thrust chamber-to-injector boltholes adjacent to lowering system attach points.

CAUTION

Binding between the injector and thrust chamber can cause damage to the thrust chamber and/or injector and add unnecessary loads to the hoist equipment.

w. Remove protective material, install seals, and lower thrust chamber injector onto thrust chamber. While lowering, keep thrust chamber injector centered on vertical axis of thrust chamber, to prevent binding between injector and thrust chamber.

x. Remove guide pins. Lubricate (Method V, section I) both sides of washers with Molykote Z powder (Dow Corning Corp); then install bolts and washers that secure thrust chamber injector to thrust chamber, fingertight.

y. Remove handler from thrust chamber injector and gimbal.

z. Raise engine by shortening turnbuckles, until gimbal is about to engage stage. Keep engine reasonably level while raising by maintaining rotation of turnbuckles within one turn of each other.

aa. Check that gimbal alines with stage. If there exists some small misalinement in the x- and z-axes, it can be compensated for by pushing on the engine about the dome area. If, however, there is gross misalinement, level engine and/or aline gimbal to stage by one or more of the following methods:

(1) Level engine by adjusting length of turnbuckles.

(2) If engine is level and gimbal does not aline, move engine in direction to aline gimbal to stage by use of adjustment mechanisms at top of turnbuckles. Adjust turnbuckles equally so that turnbuckles remain parallel to each other.

ab. With gimbal alined, raise engine with 1/6-turn increments on turnbuckles until both keyways are engaged.

ac. Continue raising engine by shortening turnbuckles until gimbal is fully engaged (less than 0.030-inch gap) with stage. To aid in prevention of binding between gimbal and stage, keep rotation of turnbuckles within one turn of each other.

ad. Secure gimbal to stage using applicable stage procedure.

CAUTION

The thrust chamber can be damaged by striking GSE or stage structure.

ae. Cross-torque bolts that secure thrust chamber injector to thrust chamber to 750 ±25 in-lb. Restrain engine while tightening bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be done because of interference with engine lowering system, make sure bolts are seated, remove engine lowering system (step ag), and then torque bolts.

af. Install bolts and washers to secure customer-connect tube support clevis to thrust chamber dome. Torque bolts to 750 ±25 in-lb.

ag. Remove engine lowering system. (Refer to section V.)

ah. Connect gimbal hydraulic actuators to engine attach points using applicable stage procedures.

ai. Connect electrical and fluid interface lines using applicable stage procedures.

aj. Remove electrical and fluid interface line supports.

ak. Disassemble track. (Refer to section V.)

al. Install gimbal boot. Torque clamp bolts to 6-8 in-lb.

NOTE

Steps am through ao outline start tank vent-and-relief valve installation.

am. Remove protective material, position valve and seal on tank flange, and secure with bolts and washers. Torque bolts to 114-126 in-lb and safetywire. (See figure 3-68.)

an. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 in-lb.

ao. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 in-lb.

ap. Remove protective material from tube ends and weld the following instrumentation lines: *(Refer to section VI for welding requirements.)*

(1) Main fuel injection pressure line (CF2)

(2) Main oxidizer injection pressure line (CO3)

(3) Thrust chamber pressure line (CG1)

aq. On engines not incorporating MD338 change, connect electrical connector (paragraph 3-31) P19 to igniter detector probe on injector dome. On engines incorporating MD330 change, connect electrical connector (paragraph 3-31) P165 to combustion temperature probe on injector dome.

ar. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, install ASI fuel lines as follows:

(1) Install bolts and washers to secure fuel manifold to thrust chamber. Torque bolts to 62-68 in-lb and safetywire.

(2) Remove protective material and install seal, bolts, and washers to secure fuel probe line to ASI fuel manifold. Torque bolts to 52-58 in-lb and safetywire.

as. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, install ASI fuel line as follows:

(1) Remove protective material and install seal between ASI fuel line and lower fuel line.

(2) Check alinement of mating holes in ASI line flange with mating holes in lower fuel line flange. Holes must aline within ±0.125 inch.

(3) Measure gap between ASI line and lower fuel line flange. Gap must be within 0.025 to 0.027 inch.

(4) Apply hand-pressure to ASI line flange until seal contacts mating surface of lower fuel line flange. Mating surfaces must be parallel within 0.025 inch.

(5) Apply hand-pressure to ASI line flange until seal contacts mating surface of lower fuel line flange. If all bolts can be installed without forcing, rotational alinement is acceptable.

CAUTION

The fuel line must be supported, to prevent excessive loads on the weld near the ASI injector when making alinement bends.

(6) If fuel line does not fall within tolerances of substeps 2 through 5, bend fuel line to meet alinement requirements. Use an approved tube-bending tool, and support the fuel line to prevent movement during alinement bending. Bends must not be made within 3 inches of any tube weld.

(7) Remove protective material and install seal, bolts, washers, and bracket on fuel line flange. Torque bolts to 40-55 in-lb.

at. Remove protective material and install temperature transducer and seal on spark igniter fuel manifold. Torque bolts to 48-53 in-lb and safetywire.

au. Connect electrical connector (paragraph 3-31) P131.

NOTE

To prevent corrosion, steps av through bm must be completed within 24 hours.

av. Using abrasive cloth, remove protective finishes and foreign matter from 4 attaching bolts and area around 4 mating holes, 90 degrees apart, on each SIC bell housing flange. Clean bonding surfaces of SIC bell housing and mating surfaces without damaging sealing surfaces.

aw. Lubricate (Method A, section I) bolts that attach ASI cable to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

ax. Lubricate (Method J, section I) ASI cable O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

ay. Install ASI SIC on ECA and secure with bolts. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

az. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire. To minimize the need to disassemble due to ASI SIC leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedures.)

ba. Install support clamps on ASI SIC pressurizing tubes with bolts, washers, and nuts. Torque nuts to 33-42 in-lb.

bb. Connect electrical connectors (paragraph 3-31) P1, P2, and P3.

bc. Lubricate (Method A, section I) bolts that attach GG SIC to ECA with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

bd. Lubricate (Method J, section I) GG SIC O-ring seals with sealing and antiseize compound RB0140-005 (Rocketdyne) or lubricant grease RB0140-012 (Rocketdyne). Make sure material does not contact bonding surface.

CAUTION

Excessive bending and twisting of SIC can damage the cable bellows.

- Bending or twisting SIC NA5-27448 can dislodge bushing from anti-rotation ring when cable is not connected and support ST3950166RKL001 is not installed. A dislodged bushing can prevent pressurization of the SIC. (SIC NA5-27448T1 has a retaining ring that will not allow the bushing to become dislodged and does not require support ST3950166RKL001.)

be. Install GG SIC on ECA with 2 bolts. Tighten bolts fingertight.

bf. Position bracket on SIC pressurizing tube bosses, and secure bracket and SIC bell housing to ECA with bolts. Tighten bolts fingertight.

bg. Install remaining bolts in SIC bell housing. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

bh. Cross-torque bolts that secure SIC to ECA in the following sequence: 15, 25, and 35 in-lb plus or minus 2 in-lb. Repeat cross-torque to 35 ±2 in-lb and safetywire.

bi. Install washers and nuts on SIC pressurizing tube bosses; torque nuts to 290 ±10 in-lb and safetywire.

bj. (Deleted)

bk. Install pressurizing valves in pressurizing tube bosses. (Refer to paragraph 3-245C.)

bl. Measure resistance from ECA to thrust chamber ground cable and from each SIC bell housing to thrust chamber. Resistance from each bell housing to thrust chamber must not exceed 100 milliohms above resistance from ECA to thrust chamber ground cable.

bm. Apply a coating of blue-tinted lacquer ST0125RB0003 (Rocketdyne) to all bonding connections.

bn. Leak-test and pressurize igniter cables. (Refer to R-3825-1B.)

bo. Install MOV (paragraph 3-188).

bp. Install oxidizer high-pressure duct (paragraph 3-214).

bq. Install purge control valve as follows:

(1) Install purge control valve and bracket on flange of oxidizer high-pressure duct with bolts. Torque bolts to 570-630 in-lb and safetywire.

(2) Weld the following lines: (See figure 3-62. Refer to section VI for welding requirements.)

(a) Overboard vent line.

(b) Purge outlet line.

(c) Purge control line.

(d) Purge inlet line.

(3) Install support clamps that secure purge control line and igniter cable to purge control valve.

br. Install fuel inlet duct (paragraph 3-66) and oxidizer inlet duct (paragraph 3-226).

bs. Refer to section IV for test requirements.

3-304. THRUST CHAMBER JACKET TEMPERATURE TRANSDUCER.

3-305. REMOVING THRUST CHAMBER JACKET TEMPERATURE TRANSDUCER. (See figure 3-70.)

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Remove support clamps as necessary, noting location for reinstallation.

c. Disconnect electrical connector (paragraph 3-30) P129 when removing thrust chamber jacket temperature transducer No. 1, and connector P130 when removing thrust chamber jacket temperature transducer No. 2.

d. Remove bolts and washers that secure transducer and insulating block to transducer mounting pad.

e. Remove screws, washers, lug, and nuts that secure transducer to connector bracket, and remove transducer.

WARNING

The following procedure specifies trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533), which are toxic solvents. Inhalation of their vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure specifies cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

f. Remove heat-sink compound from transducer and transducer mounting pad. Clean transducer and transducer mounting pad by wiping with clean, lint-free cloth dampened with trichloroethylene, cleaning compound, or trichloroethane.

3-306. INSTALLING THRUST CHAMBER JACKET TEMPERATURE TRANSDUCER. (See figure 3-70.)

a. If transducer is being replaced, verify that temperature transducer preinstallation tests in R-3825-3, Volume II have been performed.

aA. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

b. Make sure transducer, transducer mounting pad, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I).

NOTE

It is essential that there be no cavities in the compound that could cause air pockets between the transducer and the thrust chamber.

c. Spread an even coat of heat-sink compound DC340 (Dow Corning Corp) in recessed area of transducer so that recessed area is filled from flush to 1/16 inch above mating surface of transducer.

d. Loosen (do not remove) screws that secure connector bracket to bracket mounting pad.

e. Position and secure transducer on connector bracket with screws, washers, lug, and nuts. Torque nuts to 64-79 in-oz.

f. Position and secure transducer insulating block to transducer mounting pad with bolts and washers; lubricate (Method A, section I) bolts with lubricant grease RB0140-012 (Rocketdyne). Do not tighten bolts.

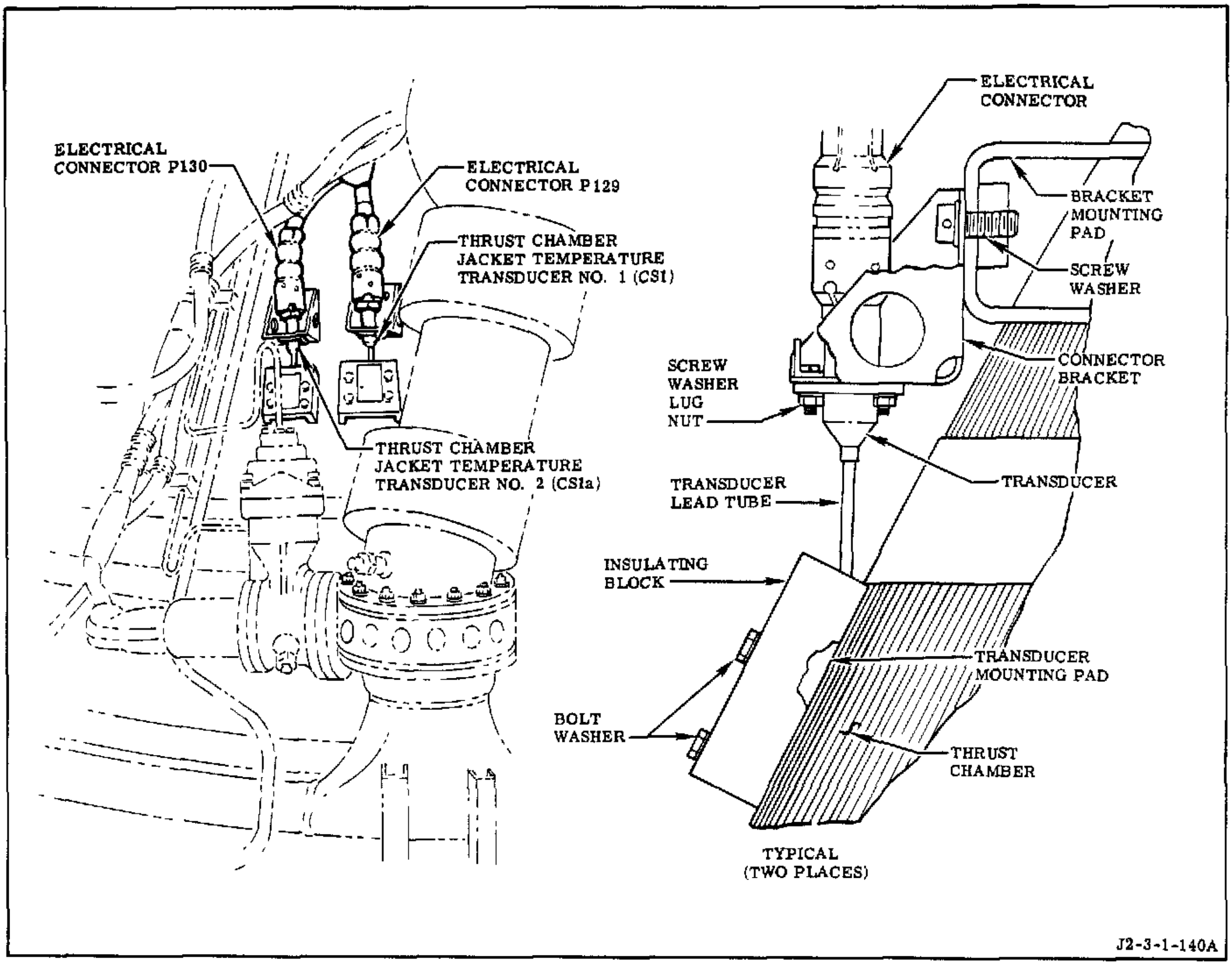


Figure 3-70. Thrust Chamber Jacket Temperature Transducers

g. Position connector bracket and insulating block, adjusting as necessary until insulating block is parallel with transducer mounting pad.

h. Alternately and progressively tighten screws in connector bracket. Torque bolts that secure insulating block to transducer mounting pad to 3-5 in-lb and safetywire. Torque screws that secure connector bracket to bracket mounting pad to 67-82 in-lb. During torquing process, make sure transducer lead tube does not become distorted.

NOTE

Electrical connectors P129 and P130 can be cross connected unless care is taken to match connector to transducer location as shown in figure 3-70.

i. Connect electrical connector (paragraph 3-31) P129 to thrust chamber jacket temperature transducer No. 1 (CS1), and connector P130 to thrust chamber jacket temperature transducer No. 2 (CS1a).

j. Install support clamps in locations noted in removal procedure.

k. Refer to section IV for test requirements.

3-307. VENT PORT CHECK VALVES.

3-308. REMOVING VENT PORT CHECK VALVES. Removed vent port check valves that are to be replaced must pass the low-temperature test and be vacuum-dried as outlined in R-3825-3, Volume II before being returned to stock.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

CAUTION

In the following step the use of an improper wrench or removal technique can cause valve damage.

b. On PU valve, remove vent port check valve, valve O-ring, bushing, and bushing O-ring as an assembly using a 6-point or a 12-point socket or box wrench. Separate bushing, valve, and O-rings.

c. At locations other than PU valve, remove vent port check valve and O-ring, K-seal, or Naflex seal (on fuel inlet duct) using a 6-point or a 12-point socket or box wrench. Remove O-ring or seal from vent port check valve.

d. Install clean protective closures (paragraph 3-258) on open ports of engine and valve.

3-309. INSTALLING VENT PORT CHECK VALVES. Replacement vent port check valves must be verified as having been low-temperature tested and vacuum-dried, and preinstallation tested as outlined in R-3825-3, Volume II before being installed.

a. When performing this procedure, observe safety precautions and contamination and damage prevention requirements in section I.

NOTE

If replacing vent port check valve 553364, use 553364-21.

b. Remove protective closures (paragraph 3-257). Make sure vent port check valve, engine mating connections, threads in parent metal, and/or threaded inserts are clean and free of damage, and threaded inserts are installed correctly (section I). Protect open ports and sealing surfaces.

c. Make sure vent port check valve is clean, free of damage that would impair correct seating, and OK to install.

d. On PU valve, install bushing, vent port check valve, and O-rings as an assembly as follows:

(1) Lubricate (Method V, section I) vent port check valve O-ring, bushing threads, and bushing O-ring with Molykote Z powder (Dow Corning Corp).

CAUTION

In the following step the use of an incorrect wrench or torque technique can cause valve damage.

(2) Remove protective material from vent port check valve, install O-ring on valve, install valve into bushing, and torque valve to 40-65 in-lb using 6-point or 12-point socket or box wrench.

(3) Install O-ring on bushing, remove protective material from PU valve port, and install vent port check valve and bushing assembly into PU valve port. Torque to 15-20 in-lb.

(4) Safetywire vent port check valve to PU valve actuator flange bolthead.

e. On MRCV, install vent port check valve and K-seal as follows: (See figure 3-70A.)

(1) Remove protective material from vent port check valve and install K-seal on check valve with flatter surface of seal against shoulder of check valve.

(2) Install check valve and K-seal into MRCV port making sure conical surface of K-seal is alined with countersink of port before valve is tightened. Torque check valve to 48-53 in-lb using a 6-point or 12-point socket or box wrench.

(3) Safetywire vent port check valve to MRCV.

CAUTION

In the following step, applying lubricant to the MFV, MOV, OTBV, or MFV closing control line vent port check valve O-ring or to the fuel inlet duct Naflex seal can result in engine damage.

f. Do not use lubricant on MFV, MOV, OTBV, or MFV closing control line vent port check valve O-rings or on fuel inlet duct Naflex seal. Lubricate other O-rings (Method J, section I) using lubricant grease RB0140-012 (Rocketdyne) as outlined in section I.

g. Install Naflex seal on vent port check valve for fuel inlet duct, or install O-ring on vent port check valve for other components. (See figure 3-70A.)

h. Remove protective closures from engine port and install valve fingertight.

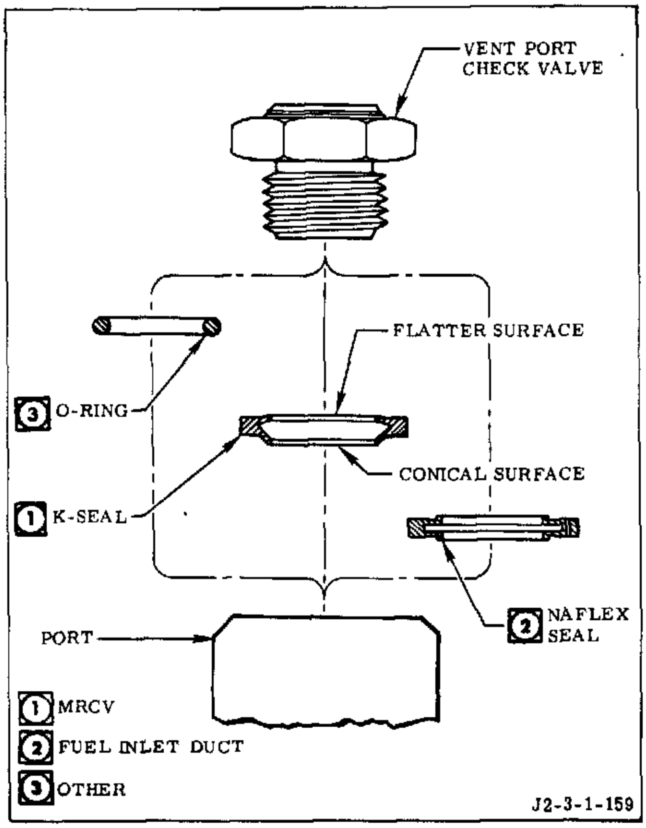


Figure 3-70A. Vent Port Check Valve and Seals

CAUTION

In the following step the use of an incorrect wrench or torque procedure can cause valve damage.

i. Torque vent port check valve to correct torque (see figure 3-71). Use a 6 or 12-point socket, except for MRCV vent port check valve use torque wrench EWR-183382.

j. Safetywire, as required. (See figure 3-71.)

Part No.	Torque (in-lb)	Safetywire Required
553364-21	40-65	Yes
553372	40-65	Yes
553372-11	40-65	Yes
553373	80-100	No
553373-11	80-100	Yes
553375	175-200	No
553375-11, -21	175-200	Yes
557809-11, -21, -31	175-200	Yes

Figure 3-71. Vent Port Check Valves

SECTION IV

POST-MAINTENANCE TEST REQUIREMENTS

4-1. SCOPE. This section contains post-maintenance test requirements that verify the integrity of engine systems affected by the removal and installation of individual engine components and lines.

4-2. DETERMINING POST-MAINTENANCE TEST REQUIREMENTS.

4-3. There are two main types of post-maintenance test requirements in this section: test requirements following complete removal and installation of a component (paragraph 4-5) and test requirements following partial removal (disconnection) and installation (reconnection) of a component (paragraph 4-8). Test requirements are applicable both to installed engines (engines installed in a stage) and uninstalled engines (engines mounted in an engine handler). The test requirements do not include methods, sequences, or limits but simply state the tests required and the points of the system to be tested. Leak-test points codes eg, (F9), (L32), (G14), etc, are identified in R-3825-1B. The test methods, sequence (unless specified), and test limits are left up to you to determine from the scheduled and trouble isolation procedures in the R-3825-1B. In some instances, special post-maintenance test requirements are specified that are not in R-3825-1B. These special post-maintenance test requirements are detailed in paragraph 4-72 in this section and are referenced accordingly in this section. The component post-maintenance test requirements are listed in this section in the same sequence as the corresponding component removal and installation procedures in section III. The system test titles in this section are the same as the corresponding test procedure titles in the R-3825-1B and in paragraph 4-72 in this section. Post-maintenance test requirements may be combined when testing is required for more than one component.

4-4. GENERAL POST-MAINTENANCE TEST CRITERIA. The following post-installation test requirements constitute general post-maintenance test criteria in this section:

a. Helium usage testing of the pneumatic system is required following complete removal and reinstallation/replacement of components in the pneumatic control system.

b. Helium supply system mass-loss testing (uninstalled engines) or pressure-decay testing (installed engines) is required following removal or disconnection of components and lines exposed to helium tank pressure, except instrumentation pressure-sensing lines and helium tank pressure transducers.

c. Helium supply system weld integrity testing is required following cutting and welding of a line exposed to helium tank pressure if the line was cut and welded after the stage acceptance test was made.

d. Start tank mass-loss testing (uninstalled engines and installed restart-mission engines) or pressure-decay testing (installed nonrestart-mission engines) is required following removal or disconnection of components and lines exposed to start tank pressure, except instrumentation pressure-sensing lines and start tank pressure transducers.

e. Start system weld integrity testing is required following cutting and welding of a line exposed to start tank pressure if the line was cut and welded after the stage acceptance test was made.

f. Engine sequence testing (the noncommutated, hardwire method, on installed engines) is required after the following maintenance tasks are performed:

(1) Disturbance of pneumatic control system connections affecting valves whose timing is checked during engine sequence testing

(2) Removal and reinstallation/replacement of ECA. If ECA was reinstalled/replaced after verification of engine valve times and if pneumatic system connections affecting valve timing were not disturbed, the valve timing verification portion of engine sequence testing may be disregarded.

g. Engine sequence testing is required to verify correct electrical control system operation and sequence of events after the following maintenance tasks are performed: (Sequence testing on installed engines may be accomplished using stage telemetry if pneumatic system connections affecting valve timing were not disturbed.)

(1) Disconnection/reconnection of ECA package electrical power connectors P1, P2, and P3

(2) Disconnection/reconnection of any control system armored harness connector except P17 (helium tank emergency vent control valve)

(3) Disconnection/reconnection of interface electrical connector P51, P54, P105, or P107 on installed engines

(4) Disconnection/reconnection of primary FI package connector P101 or P104

(5) Disconnection/reconnection of valve connectors that carry valve position indicator (switch and potentiometer) signals

4-5. DETERMINING POST-INSTALLATION TEST REQUIREMENTS FOR COMPLETELY REMOVED COMPONENTS.

4-6. Each component removed and installed in section III that requires post-installation testing has a corresponding test requirement paragraph in this section. Because these requirements are based on the procedures in section III, deviations from those procedures may require the user to make appropriate changes in the post-installation test requirements.

4-7. Test requirement paragraphs identify applicable engine system tests or required portions of tests, specific items to be tested (and applicable leak-test point code numbers in parentheses), and allowable deviations from normal system test requirements. Where performance of test requirements creates other test requirements (eg, when connections are disturbed while installing exhaust system test plates), these secondary test requirements are also included in the test requirement paragraph. Post-installation test requirements for components that are not contained in section III are included in the miscellaneous post-maintenance test requirements of paragraph 4-77; the user must determine the specific items to be tested.

4-8. DETERMINING POST-INSTALLATION TEST REQUIREMENTS FOR PARTIALLY REMOVED COMPONENTS.

4-9. Partial removal is defined in this section as those tasks consisting of merely disconnecting various parts of engine systems or cutting various engine system lines. These tasks can vary to such an extent that separate post-maintenance (post-installation) test requirement paragraphs are not practical. Test requirements for these tasks (including test requirements that result from performance of other post-maintenance tests) are listed with the miscellaneous post-maintenance test requirements in paragraph 4-77. The user must determine the specific items to be tested.

4-10. <u>POST-INSTALLATION TEST REQUIREMENTS FOR COMPLETELY REMOVED COMPONENTS.</u>

4-11. ARMORED HARNESS POST-INSTALLATION TEST REQUIREMENTS. Post-installation test requirements for armored harnesses are limited to tests required for the electrical connectors that were disconnected and reconnected. (Refer to paragraph 4-17.)

4-12. AUGMENTED SPARK IGNITER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required) (applicable to installed engines only)	(1) Oxidizer inlet duct connection to turbopump (L1) and/or inlet duct connection to stage, as applicable for connections disturbed
	(2) LOX BLEED LINE customer connect (SII-stage center engines only)
b. Fuel feed system test (leak test) exhaust system test plates not required) (applicable to installed engines only)	(1) Fuel inlet duct connection to turbopump (F9) and/or inlet duct connection to stage, as applicable for connections disturbed

Test Required	Item Tested
	(2) FUEL BLEED LINE customer connect (SII-stage center engines only)
c. Thrust chamber test (leak test)	(1) ASI valve connection to ASI oxidizer line (L32)
	(2) Flange seal between ASI and thrust chamber injector (L35)
	(3) Ignition detector probe flange (G14)
	(4) Upper and lower ASI fuel line flange connections (F49)
	(5) HYDROGEN TANK PRESSURIZATION customer connect (SII-stage engines only)
d. Oxidizer tank pressurization system leak test	OXIDIZER TANK PRESSURIZATION customer connect (SII-stage center engines only)
e. Spark igniter test	ASI and GG spark igniters; ECA connector P2
f. Mainstage OK pressure switch test (function test only)	Pressure switch circuits; ECA connector P3
g. Pneumatic control system test (function test and component-test-circuit checkout only)	(1) Helium tank emergency vent control valve operation; ECA connectors P1 and P3
	(2) Helium, ignition-phase, STDV, and mainstage control valve operation; ECA connector P2
h. Flight instrumentation system test (temperature transducer testing)	ECA temperature transducers No. 1 and No. 2; ECA connector P2
i. Engine sequence test: (Stage telemetry may be used.)	
(1) Engine power buses energized	On installed engines, ignition detector (or dummy) probe, circuit, and connector P19 continuity verified when the following results are obtained:
	(a) On engines not incorporating MD338 change, engine-ready indication obtained and ignition-complete indication not obtained.
	(b) On engines incorporating MD338 change, engine-ready and ignition-complete indications both obtained.
(2) Sequence test	Engine control system operation and correct event sequence
j. Helium supply system pressure-decay test	Helium supply system

4-13. AUGMENTED SPARK IGNITER LOWER FUEL LINE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
Thrust chamber test (leak test)	a. Upper and lower fuel line connections (F49)
	b. ASI fuel line connection to thrust chamber fuel inlet manifold (F37)
	c. Start tank liquid refill flange on ASI fuel line (F50)

4-14. AUGMENTED SPARK IGNITER VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required)	ASI valve flange connection to MOV (L22)
b. Thrust chamber test (leak test)	ASI valve connection to ASI oxidizer line (L32)
c. Pneumatic control system:	
(1) Leak test with helium control valve energized	ASI valve closing control port (P12)
(2) Leak test with helium and ignition-phase control valves energized	ASI valve opening control port (P11)
d. Mainstage OK pressure switch test (leak test only)	Calips checkout line
e. Engine sequence test (hardwire)	Engine valve timing, valve actuation sequence; ASI valve position indicator switch operation (connector P120)
f. Engine pneumatic system helium usage test	Pneumatic control system

4-15. AUXILIARY FLIGHT INSTRUMENTATION PACKAGE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. Post-installation test requirements for individual transducers are in paragraph 4-16.

Test Required	Item Tested
a. Flight instrumentation system test:	

NOTE

If a transducer was replaced, the initial voltage checkout requirements in paragraph 4-74 must be performed for that transducer, instead of the requirements in substep 1.

Test Required	Item Tested
(1) Pressure transducer testing	(a) Main fuel injection CF2
	(b) Main oxidizer injection CO3
	(c) GG fuel injector GF4
	(d) GG oxidizer injector GO5
	(e) Helium tank (redundant) NN1 (on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)
	(f) Heat exchanger oxidizer inlet HO1 (on engines for SII stage)

Test Required	Item Tested
	(g) Helium regulator assembly outlet NN2
	(h) Fuel turbopump balance piston cavity PF5
	(i) Oxidizer turbopump primary seal PO6
	(j) Oxidizer turbopump bearing coolant PO7 or start tank (redundant) TF1 (on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)
	(k) PU valve inlet PO8
	(l) PU valve outlet PO9
	(m) Oxidizer turbine inlet TG3
	(n) Oxidizer turbine outlet TG4
(2) Temperature transducer testing	Auxiliary FI package temperature transducer
b. Oxidizer feed system test (leak test) (exhaust system test plates not required)	(1) Heat exchanger oxidizer inlet pressure HO1 instrumentation line weld (on engines for SII stage)
	(2) Oxidizer turbopump bearing coolant pressure PO7 instrumentation line weld (on engines not incorporating MD269, MD282, MD296, MD313, or MD315 change)
	(3) PU valve inlet pressure PO8 instrumentation line weld
	(4) PU valve outlet pressure PO9 instrumentation line weld

Test Required	Item Tested
c. Fuel feed system test (leak test) (exhaust system test plates not required)	Fuel turbopump balance piston cavity pressure PF5 instrumentation line weld
d. Oxidizer turbopump primary seal drain line leak test	Oxidizer turbopump primary seal cavity pressure PO6 instrumentation line weld
e. Thrust chamber test (leak test)	(1) Main fuel injection pressure CF2 instrumentation line weld
	(2) Main oxidizer injection pressure CO3 instrumentation line weld
f. Gas generator and exhaust system test (leak test)	(1) GG fuel injector pressure GF4 instrumentation line weld
	(2) Oxidizer turbine inlet pressure TG3 instrumentation line weld
	(3) Oxidizer turbine outlet pressure TG4 instrumentation line weld

NOTE

The test requirements in step g are applicable after the exhaust system test plates are removed.

g. Pneumatic control system test

NOTE

The test requirements in substeps 1 and 2 must be selected as applicable for the pneumatic control ports disturbed during installation and removal of the exhaust system test plates.

Test Required	Item Tested
(1) Leak test with helium control valve energized	(a) Helium regulator outlet pressure NN2 instrumentation line weld

Test Required	Item Tested
	(b) OTBV opening control port (P22)
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21)
	(b) Purge control valve inlet line flange (P19)
(3) Leak test of purge control valve and purge lines	(a) GG oxidizer injector pressure GO5 instrumentation line weld
	(b) Purge control valve outlet line flange (P18) if disturbed in test in step d.
h. Helium supply system leak test	Helium tank pressure NN1 (redundant) instrumentation line weld (on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)
i. Helium supply system weld integrity test requirements	(Refer to paragraph 4-75.)
j. Engine (hardwire) sequence test (performed after exhaust system test plates are removed)	Engine valve timing, valve actuation sequence, and OTBV operation
k. Start system test (leak test)	Start tank pressure TF1 (redundant) instrumentation line weld

Test Required	Item Tested
l. Start system weld integrity test requirements	(Refer to paragraph 4-76.)

4-16. AUXILIARY FLIGHT INSTRUMENTATION PACKAGE AND PRIMARY FLIGHT INSTRUMENTATION PACKAGE TRANSDUCER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. Test requirements for individual pressure transducers must be selected, as applicable, from the requirements in this paragraph. When all transducers in an instrumentation package are affected by a maintenance task, or when the entire package is removed and reinstalled/replaced, the test requirements for the auxiliary package (paragraph 4-15) or the primary package (paragraph 4-56) may be used instead of this paragraph.

Test Required	Item Tested

NOTE

The test requirements in step a must be selected for the particular transducer to be tested.

a. Flight instrumentation system test:

NOTE

If a transducer was replaced, the initial voltage checkout requirements in paragraph 4-74 must be performed for that transducer instead of the requirements in substep 1.

Test Required	Item Tested
(1) Pressure transducer testing (auxiliary FI package)	(a) Main fuel injection CF2

Test Required	Item Tested
	(b) Main oxidizer injection CO3
	(c) GG fuel injector GF4
	(d) GG oxidizer injector GO5
	(e) Helium tank (redundant) NN1 (on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)
	(f) Heat exchanger oxidizer inlet HO1 (on engines for SII stage)
	(g) Helium regulator assembly outlet NN2
	(h) Fuel turbopump balance piston cavity PF5
	(i) Oxidizer turbopump primary seal PO6
	(j) Oxidizer turbopump bearing coolant PO7 on engines not incorporating MD269, MD282, MD296, MD313, or MD315 change
	(k) PU valve inlet PO8
	(l) PU valve outlet PO9
	(m) Start tank TF1 (redundant) on engines incorporating MD269, MD282, MD296, MD313, or MD315 change
	(n) Oxidizer turbine inlet TG3
	(o) Oxidizer turbine outlet TG4

Test Required	Item Tested
(2) Pressure transducer testing (primary F1 package)	(a) Thrust chamber CG1
	(b) GG chamber GG1 on engines not incorporating MD237 change
	(c) Helium tank NN1
	(d) Fuel turbopump discharge PF3
	(e) Oxidizer turbopump discharge PO3
	(f) Start tank TF1
	(g) Fuel turbine inlet TG1 on engines incorporating MD237 change

NOTE

The test requirements in step b are applicable to auxiliary transducers HO1, PO7, PO8, and PO9, and to primary transducer PO3.

Test Required	Item Tested
b. Oxidizer feed system test (leak test) (exhaust system test plates not required)	(1) Heat exchanger oxidizer inlet pressure HO1 instrumentation line weld (on engines for SII stage)
	(2) Oxidizer turbopump bearing coolant pressure PO7 instrumentation line weld (on engines not incorporating MD269, MD282, MD296, MD313, or MD315 change)
	(3) PU valve inlet pressure PO8 instrumentation line weld
	(4) PU valve outlet pressure PO9 instrumentation line weld
	(5) Oxidizer turbopump discharge pressure PO3 instrumentation line weld

Test Required	Item Tested

NOTE

The test requirements in step c are applicable to auxiliary transducer PF5 and to primary transducer PF3.

Test Required	Item Tested
c. Fuel feed system test (leak test) (exhaust system test plates not required)	(1) Fuel turbopump balance piston cavity pressure PF5 instrumentation line weld
	(2) Fuel turbopump discharge pressure PF3 instrumentation line weld

NOTE

The test requirements in step d are applicable to auxiliary transducer PO6.

Test Required	Item Tested
d. Oxidizer turbopump primary seal drain line leak test	Oxidizer turbopump primary seal cavity pressure PO6 instrumentation line weld

NOTE

The test requirements in step e are applicable to auxiliary transducers CF2 and CO3, and to primary transducer CG1.

Test Required	Item Tested
e. Thrust chamber test (leak test)	(1) Main fuel injection pressure CF2 instrumentation line weld
	(2) Main oxidizer injection pressure CO3 instrumentation line weld
	(3) Thrust chamber pressure CG1 instrumentation line weld

NOTE

The test requirements in step f are applicable to auxiliary transducers GF4, TG3, and TG4, and to primary transducer GG1 or TG1 (as applicable).

- The test requirements in step g, as applicable, and step h are required following removal of the exhaust system test plates.

Test Required	Item Tested
f. Gas generator and exhaust system test (leak test)	(1) GG fuel injector pressure and purge line pressure GF4 instrumentation line weld
	(2) Oxidizer turbine inlet pressure TG3 instrumentation line weld
	(3) Oxidizer turbine outlet pressure TG4 instrumentation line weld
	(4) On engines not incorporating MD237 change, GG chamber pressure GG1 instrumentation line weld
	(5) On engines incorporating MD237 change, fuel turbine inlet pressure TG1 instrumentation line weld

NOTE

The test requirements in step g are applicable to auxiliary transducers GO5 and NN2.

g. Pneumatic control system test:

NOTE

The test requirements in substeps 1 and 2 must be selected as applicable for the pneumatic control ports disturbed during installation and removal of the exhaust system test plates.

Test Required	Item Tested
(1) Leak test with helium control valve energized	(a) Helium regulator outlet pressure NN2 instrumentation line weld

Test Required	Item Tested
	(b) OTBV opening control port (P22)
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21)
	(b) Purge control valve inlet line flange (P19)
(3) Leak test purge control valve purge line (GO5 only)	(a) GG oxidizer injector pressure GO5 instrumentation line weld
	(b) Purge control valve outlet line flange (P18) if disturbed in test in step d

NOTE

The test requirements in step h are applicable after the exhaust system test plates are removed and step g performed, if the OTBV control ports were disturbed.

Test Required	Item Tested
h. Engine sequence test (hardwire)	Engine valve timing and OTBV operation

NOTE

The test requirements in step i are applicable to transducer NN1 (primary and redundant auxiliary).

Test Required	Item Tested
i. Helium supply system leak test	Helium tank pressure NN1 instrumentation line weld (applicable to auxiliary FI package on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)
j. Helium supply system weld integrity test requirements	(Refer to paragraph 4-75.)

NOTE

The test requirements in step k are applicable to transducer TF1 (primary and redundant auxiliary).

Test Required	Item Tested
k. Start system test (leak test)	Start tank pressure TF1 instrumentation line weld (applicable to auxiliary FI package on engines incorporating MD269, MD282, MD296, MD313, or MD315 change)
l. Start system weld integrity test requirements	(Refer to paragraph 4-76.)

4-16A. DUMMY IGNITION DETECTOR PROBE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-installation test requirements are in paragraph 4-2. Post-installation test of this component consists of energizing engine ignition and control power buses, and verifying that a ignition-complete indication is obtained.

4-17. ELECTRICAL CONNECTOR POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-installation test requirements are in paragraph 4-2. Test requirements for individual connectors must be selected, as applicable, from the requirements in this paragraph. Figure 4-1 lists the system test requirements detailed in this paragraph that are applicable to individual connectors. In some instances FI system test requirements for a particular connector are located in more than one substep, eg, auxiliary FI package connector P150 is listed with test requirements in substeps 2 and 3 of pressure transducer testing, step a.

Connector Number	Component or System Associated With Connector	System Test Requirements										
		FI System Pressure Transducer Test	FI System Temperature Transducer Test	FI System Speed and Flow Transducer Test	FI System Valve Position Indicator Test	PU Valve or MRCV Test	Start Tank Emergency Vent Valve Test	Pneumatic Control System (Function) Test	Spark Igniter (Function) Test	Mainstage OK Pressure Switch (Function) Test	Engine Sequence Test	Engine Electrical Power Checkout
P1	ECA							X[c]			X	
P2	ECA		X					X	X		X	
P3	ECA							X[c]		X	X	
P13	Helium control valve										X	
P14	Ignition-phase control valve										X	
P15	Mainstage control valve										X	
P16	(a)											
P17	Helium tank emergency vent control valve							X[c]				
P18	STDV control valve										X	
P19	Ignition detector probe										X	
P20	Pressure switch No. 1									X		
P21	(a)											
P22	(b)											
J/P25	Interconnect (OTBV position)										X	
P26	Pressure switch No. 2									X		
P36	PU valve[d]					X						
P38	Interface[d]					X						
P36A	MRCV[e]					X[f]						
P38	Interface[e]											
P51	Interface							X[c]			X	
P54	Interface						X		X		X	
P55	Start tank emergency vent valve						X[f]					
P100	Primary FI package	X			X							
P101	Primary FI package				X						X	
P102	Primary FI package	X										
P103	Primary FI package	X	X									
P104	Primary FI package				X						X	
P105	Interface	X										
P106	Interface	X	X									
P107	Interface				X						X	
P108	Interface		X									
P109	Interface			X								
P110	Fuel flowrate			X								
J110A	Redundant fuel flowrate			X								

(a) Spare connector.
(b) No test requirements.
(c) Helium supply system pressure-decay test required if helium emergency vent valve actuated after scheduled engine checkout at KSC.
(d) Engines *not* incorporating MD366 or MD371 change.
(e) Engines incorporating MD366 or MD371 change.
(f) Audible verification of solenoid actuation (click test) without pressure in system is an acceptable test.

Figure 4-1. Electrical Connector Test Requirements (Sheet 1 of 3)

Connector Number	Component or System Associated With Connector	System Test Requirements: FI System Pressure Transducer Test	FI System Temperature Transducer Test	FI System Speed and Flow Transducer Test	FI System Valve Position Indicator Test	PU Valve or MRCV Test	Start Tank Emergency Vent Valve Test	Pneumatic Control System (Function) Test	Spark Igniter (Function) Test	Mainstage OK Pressure Switch (Function) Test	Engine Sequence Test	Engine Electrical Power Checkout
P111	Oxidizer flowrate			X								
J111A	Redundant oxidizer flowrate			X								
P112	Fuel turbopump speed			X								
P113	Oxidizer turbopump speed			X								
P114	MFV position				X						X	
P115	MOV position				X						X	
P116	GG control valve position				X						X	
P117	OTBV position				X						X	
P118	STDV position				X						X	
P119	PU valve position[d]				X	X						
P119 or P119A	MRCV position [e]				X	X						
P120	ASI valve position										X	
P122	Helium tank gas temp		X									
P123	Start tank gas temp		X									
P124	Fuel pump outlet temp		X									
P125	Oxidizer pump outlet temp		X									
P126	Fuel turbine inlet temp		X									
P127	Oxidizer turbine inlet temp		X									
P128	Oxidizer turbine exhaust temp		X									
P129	Thrust chamber jacket temp No. 1		X									
P130	Thrust chamber jacket temp No. 2		X									
P131	Fuel injection temp		X									
P132	Oxidizer bleed valve position										X	
P133	Fuel bleed valve position										X	
P141	Fuel interstage pressure	X										
P150	Auxiliary FI package	X										

(d) Engines not incorporating MD366 or MD371 change.
(e) Engines incorporating MD366 or MD371 change.

Figure 4-1. Electrical Connector Test Requirements (Sheet 2 of 3)

Connector Number	Component or System Associated With Connector	System Test Requirements: FI System Pressure Transducer Test	FI System Temperature Transducer Test	FI System Speed and Flow Transducer Test	FI System Valve Position Indicator Test	PU Valve or MRCV Test	Start Tank Emergency Vent Valve Test	Pneumatic Control System (Function) Test	Spark Igniter (Function) Test	Mainstage OK Pressure Switch (Function) Test	Engine Sequence Test	Engine Electrical Power Checkout
P151	Auxiliary FI package	X	X									
P152	Auxiliary FI package	X										
P153	Interface	X										
P154	Interface	X	X									
P155	Interface	X										
P156	Interface		X				X(f)					
P157	Heat exchanger outlet temp		X									
P158	Fuel bleed valve temp		X									
P159	Oxidizer bleed valve temp		X									
J160	(b)											
P161	Fuel pump bearing temp		X									
P162	Oxidizer pump bearing temp		X									
J163	(a)											
P164	(b)											
P167	(b)											
J180	Interconnect (start tank emergency vent valve)						X					

(a) Space connector
(b) No test requirements
(f) Audible verification of solenoid actuation (click test) without pressure in system is an acceptable test.

Figure 4-1. Electrical Connector Test Requirements (Sheet 3 of 3)

Test Required	Item Tested
a. Flight instrumentation system test (pressure transducer testing)	(1) The following primary FI package pressure transducer signals if connector P100 or P103 (primary FI package), or P105 or P106 (engine interface) was disconnected and reconnected:
	(a) Thrust chamber CG1
	(b) GG chamber GG1, or on engines incorporating MD237 change, fuel turbine inlet TG1
	(c) Helium tank NN1
	(d) Fuel turbopump discharge PF3
	(e) Oxidizer turbopump discharge PO3
	(f) Start tank TF1
	(g) Fuel turbopump interstage PF6 (on engines not incorporating MD233 change), or on engines incorporating MD304 change, thrust chamber (low-range) pressure
	(2) The following auxiliary FI package pressure transducer signals if connector P150 or P151 (auxiliary FI package), or P153 or P154 (engine interface) was disconnected and reconnected:
	(a) GG fuel injector GF4
	(b) GG oxidizer injector GO5
	(c) Heat exchanger oxidizer inlet HO1 (on engines for SII stage only)
	(d) Helium tank (redundant) NN1 on engines incorporating MD269, MD282, MD296, MD313, or MD315 change
	(e) Oxidizer turbopump primary seal PO6
	(f) Oxidizer turbopump bearing coolant PO7 or on engines incorporating MD269, MD282, MD296, MD313, or MD315 change, start tank (redundant) TF1
	(g) PU valve inlet PO8
	(h) PU valve outlet PO9
	(3) The following auxiliary FI package pressure transducer signals if connector P150 or P152 (auxiliary FI package), or P153 or P155 (engine inteface) was disconnected and reconnected:
	(a) Main fuel injection CF2
	(b) Main oxidizer injection CO3
	(c) Helium regulator outlet NN2

Test Required	Item Tested
	(d) Fuel turbopump balance piston cavity PF5
	(e) Oxidizer turbine inlet TG3
	(f) Oxidizer turbine exhaust TG4
	(4) Turbopump interstage pressure PF6 (on engines not incorporating MD233 change), or on engines incorporating MD304 change, thrust chamber (low-range) pressure if connector P102 (primary FI package) or P141 (transducer) was disconnected and reconnected.
b. Flight instrumentation system test (temperature transducer testing)	(1) ECA temperature transducers No. 1 and No. 2 if connector P2 (ECA) was disconnected and reconnected.
	(2) Primary FI package temperature transducer if connector P103 (primary FI package) or P106 (engine interface) was disconnected and reconnected.
	(3) Auxiliary FI package temperature transducer if connector P151 (auxiliary FI package) or P154 (engine interface) was disconnected and reconnected.
	(4) All temperature transducer signals in substep 5 if connector P108 (engine interface) was disconnected and reconnected.

Test Required	Item Tested
	(5) The following temperature transducer signals, as applicable, for transducer connector disconnected and reconnected:
	(a) P122: helium tank gas NNT1
	(b) P123: start tank gas TFT1
	(c) P124: fuel turbopump discharge PFT1
	(d) P125: oxidizer turbopump discharge POT3
	(e) P126: fuel turbine inlet TGT1 on engines not incorporating MD263 change
	(f) P127: oxidizer turbine inlet TGT3 on engines not incorporating MD263 change
	(g) P128: oxidizer turbine exhaust TGT4 on engines not incorporating MD263 or MD355 change
	(h) P129: thrust chamber jacket No. 1 CS1
	(i) P130: thrust chamber jacket No. 2 CS1a
	(j) P131: main fuel injection CFT2

Test Required	Item Tested
	(6) All temperature transducer signals in substep 7 if connector P156 (engine interface) was disconnected and reconnected.
	(7) The following temperature transducer signals, as applicable, for transducer connector disconnected and reconnected:
	(a) P157: heat exchanger oxidizer outlet HOT2 (on engines for SII stage only)
	(b) P158: fuel bleed valve--fuel temperature GFT1
	(c) P159: oxidizer bleed valve--oxidizer temperature GOT2
	(d) P161: fuel turbopump bearing PST1 on engines not incorporating MD172 or MD248 change
	(e) P162: oxidizer turbopump bearing coolant POT4
c. Flight instrumentation system test (speed and flow transducer testing)	(1) P109 (engine interface): all speed and flow transducer signals in substep 2
	(2) Oxidizer and fuel flowmeter and turbopump speed transducer signals, as applicable, for transducer connector disconnected:
	(a) P110: main fuel flowrate PFF
	(b) P111: main oxidizer flowrate POF
	(c) P112: fuel turbopump speed PFV
	(d) P113: oxidizer turbopump speed POV
	(3) On engines not incorporating MD150, MD280, or MD281 change, the following redundant flowrate signals, as applicable, for interface connector disconnected and reconnected:
	(a) J110A: redundant fuel flowrate PFFa
	(b) J111A: redundant oxidizer flowrate POFa
d. Flight instrumentation system test (valve position indicator calibration test on uninstalled engines only)	(1) All position indicator signals in substep 2 if connector P101 or P104 (primary FI package) was disconnected and reconnected.
	(2) The following valve position indicator signals, as applicable, for position transducer connector disconnected and reconnected:
	(a) P114: MFV
	(b) P115: MOV
	(c) P116: GG control valve
	(d) P117: OTBV

Test Required	Item Tested
	(e) *P118: STDV*
	(f) P119: PU valve
e. Propellant utilization valve test	PU valve control circuits: P36 (valve control power), P119 (valve position potentiometer), or P38 (engine interface)
f. Start tank emergency vent valve test (on engines incorporating MD320 or MD351 change)	Start tank emergency vent valve operation; P55 (valve), P156 (engine interface), or J180 (electrical system interconnect)
g. Pneumatic control system test (function test and component-test-circuit checkout only)	(1) Helium tank emergency vent control valve operation; P1 or P3 (ECA), P17 (valve), or P51 (engine interface)
	(2) Helium, ignition-phase, STDV, and mainstage control valve operation; P2 (ECA) or P54 (engine interface)

NOTE

The test requirements in step h are applicable to engines not incorporating MD333 change, after helium tank emergency vent control valve function testing, if the helium emergency vent valve was actuated after the scheduled helium supply system pressure-decay test at KSC.

Test Required	Item Tested
h. Helium supply system pressure-decay test	Helium supply system, applicable in conjunction with post-installation testing for connector P1 or P3 (ECA), P17 (helium tank emergency vent control valve), or P51 (engine interface)
i. *Spark igniter test* (function test only for component-test-circuit checkout)	*Spark igniter circuits;* P2 (ECA) or P54 (engine interface)
j. Mainstage OK pressure switch test (function test only)	(1) Pressure switch circuits; P3 (ECA)
	(2) P20: mainstage OK pressure switch No. 1
	(3) P26: mainstage OK pressure switch No. 2
k. Engine sequence test (Stage telemetry may be used.)	(1) Engine control system operation and correct event sequence verification required if any of the following connectors were disconnected and reconnected:
	(a) P1, P2, or P3 (ECA)
	(b) (Deleted)
	(c) P51, P54, or P105 (engine interface)
	(d) P13 (helium control valve)
	(e) P14 (ignition-phase control valve)
	(f) P15 (mainstage control valve)
	(g) P18 (STDV control valve)

Test Required	Item Tested
	(2) Verification of all valve position indicator signals in substep 3 required if connector P101 or P104 (primary FI package), or P107 (engine interface) was disconnected and reconnected.
	(3) Verification of the following valve position indicator signals, as applicable, for position transducer connector disconnected and reconnected: (a) P114: MFV (b) P115: MOV (c) P116: GG control valve (d) P117: OTBV (e) P118: STDV (f) P120: ASI valve (position switch) (g) P132: oxidizer bleed valve (position switch) (h) P133: fuel bleed valve (position switch)

NOTE

The test requirements in step 1 may be complied with in conjunction with engine sequence testing.

Test Required	Item Tested
1. Engine power buses energized (special post-maintenance test requirements applicable to installed engines only)	(1) J/P25 (OTBV position switch): circuit and connector continuity is verified when engine-ready indication is obtained.
	(2) P19 (ignition detector or dummy probe): probe, circuit, and connector continuity verified when the following results are obtained: (a) On engines not incorporating MD338 change, engine-ready indication obtained and ignition-complete indication not obtained. (b) On engines incorporating MD338 change, engine-ready and ignition-complete indications obtained.

4-18. ELECTRICAL CONTROL ASSEMBLY POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2.

NOTE

On uninstalled engines, the test requirements in step a must be performed before steps c through g.

Test Required	Item Tested
a. Engine electrical safety circuit test	ECA safety circuits
b. Flight instrumentation system test (temperature transducer testing)	ECA temperature transducers No. 1 and No. 2; ECA connector P2
c. Pneumatic control system test (function test and component-test-circuit checkout only)	(1) Helium tank emergency vent control valve operation; ECA connectors P1 and P3
	(2) Helium, ignition-phase, STDV, and mainstage control valve operation; ECA connector P2

Test Required	Item Tested

NOTE

The test requirements in step d are applicable on engines not incorporating MD333 change, after helium tank emergency vent control valve function testing, if the helium emergency vent valve was actuated after the scheduled helium supply system pressure-decay test at KSC.

Test Required	Item Tested
d. Helium supply system pressure-decay test	Helium supply system
e. Mainstage OK pressure switch test (*function test only*)	Pressure switch circuits; ECA connector P3
f. Spark igniter test (function test only)	Spark igniter circuits; ECA connector P2
g. Engine sequence test	(1) Verification of correct electrical indications before engine sequence start
	(2) Hardwire verification of ECA timers if ECA was removed or replaced after verification of engine valve times.
	(3) Hardwire verification of engine valve times, ECA timers, and valve actuation sequence if ECA was removed or replaced before verification of engine valve times.

4-19. FAST-SHUTDOWN VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Pneumatic control system test	
(1) Leak test with helium control valve energized	(a) Fast-shutdown valve diaphragm leakage
	(b) Control line weld
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) Inlet port (P33)
	(b) Fast-shutdown valve seat leakage
b. Engine pneumatic system helium usage test	Pneumatic control system
c. Engine sequence test (hardwire)	Engine valve timing, valve actuation sequence, and GG control valve operation

4-20. FUEL BLEED LINE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
Fuel feed system (leak test) (exhaust system test plates not required)	Fuel bleed line connections at bleed valve (F18) and customer connect

4-21. FUEL BLEED VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Fuel feed system test (leak test) (exhaust system test plates not required)	(1) Fuel bleed valve capped port GF5 (F16) if valve was replaced or port disturbed (on engines not incorporating MD237 change)

Test Required	Item Tested
	(2) Fuel bleed valve--fuel temperature transducer GFT1 (F17)
	(3) Fuel bleed line connection to fuel bleed valve (F18)
	(4) Fuel bleed valve connection to fuel bleed valve adapter (GG fuel line) (F19)
	(5) Fuel bleed valve leakage
b. Pneumatic control system test: (leak test with helium control valve energized)	Fuel bleed valve closing control port (P35)
c. Flight instrumentation system test (temperature transducer test)	Fuel bleed valve--fuel temperature transducer GFT1 (connector P158)
d. Engine sequence test (hardwire)	Engine valve timing, valve actuation sequence, and fuel bleed valve position indicator operation (connector P133)
e. Engine pneumatic system helium usage test	Pneumatic control system

4-22. FUEL FLOWMETER AND FLOW STRAIGHTENER POST-INSTALLATION TEST REQUIREMENTS. Post-installation test requirements for the fuel flowmeter and flow straightener are identical to post-installation test requirements for the fuel high-pressure duct in which the flowmeter and flow straightener are installed. (Refer to paragraph 4-23.)

4-22A. FUEL FLOW TRANSDUCER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
Flight instrumentation system test (speed and flow transducer testing)	Main fuel flowrate transducer PFF (connector P110) and (on engine not incorporating MD150, MD280, or MD281 change) PFFa (connector P110a)

4-23. FUEL HIGH-PRESSURE DUCT POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Fuel feed system test (leak test) (exhaust system test plates not required)	(1) MFV upstream flange (F6)
	(2) Fuel turbopump discharge fluid-temperature transducer PFT1 (F7)
	(3) Fuel turbopump connection to high-pressure duct (F14)
	(4) Fuel bleed valve adapter (GG fuel line) connection to fuel high-pressure duct (F20)
	(5) Fuel turbopump discharge pressure PF3 instrumentation port (F21) and line weld
	(6) Fuel flowmeter flange (F22)
b. Flight instrumentation system test:	
(1) Temperature transducer testing	Fuel turbopump discharge fluid-temperature transducer PFT1 (connector P124)
(2) Speed and flow transducer testing	Main fuel flowrate transducer PFF (connector P110) and (on engines not incorporating MD150, MD280, or MD281 change) PFFa (connector J110A)

4-24. FUEL INLET DUCT POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2.

Test Required	Item Tested
Fuel feed system test (leak test) (exhaust system test plates not required)	Fuel inlet duct connection to turbopump (F9) and inlet duct connection to stage

4-25. FUEL JACKET PURGE CHECK VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2.

Test Required	Item Tested
Thrust chamber test (leak test)	a. Fuel jacket purge check valve connection to fuel inlet manifold (F39)
	b. Thrust chamber jacket purge line weld (upstream side of check valve)
	c. Fuel jacket purge check valve (reverse leakage)

4-26. FUEL TURBINE EXHAUST DUCT POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2. These test requirements are also part of the fuel turbopump post-installation test requirements (paragraph 4-27), which may be used in lieu of this paragraph if fuel turbopump post-installation testing is also required.

Test Required	Item Tested
a. Gas generator and exhaust system test (leak test)	(1) Fuel turbine exhaust duct connection to oxidizer turbine inlet (G1)
	(2) OTBV inlet pressure instrumentation port TG8 (G15) (on engines not incorporating MD237 change)
	(3) Fuel turbopump connection to turbine exhaust duct (G29)
	(4) The following leak-test points if exhaust duct was replaced or if these items were disturbed:
	(a) OTBV inlet temperature transducer port TGT6 (G16) (on engines not incorporating MD237 change)
	(b) Fuel turbine exhaust temperature transducer port TGT2 (G26)
	(c) Fuel turbine exhaust pressure TG2 instrumentation port (G27)
	(d) Fuel turbine exhaust drain port (G28)

NOTE

The test requirements in steps b through d are applicable after the exhaust system test plates are removed.

Test Required	Item Tested
b. Pneumatic control system test:	
(1) Leak test with helium control valve energized	OTBV opening control port (P22)
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21)
	(b) Purge control valve inlet line flange (P19) (if line was removed)

Test Required	Item Tested
c. Engine sequence test (hardwire)	Engine valve timing, valve actuation sequence, and OTBV operation and position indicator (connector P117)
d. Engine pneumatic system helium usage test	Pneumatic control system
e. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	OTBV position indicator (connector P117)

4-27. FUEL TURBOPUMP POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test	GG oxidizer line connection to GG (L28)
b. Fuel feed system test:	
(1) Leak test	(a) GG fuel line connection to GG (F8)
	(b) Fuel inlet duct connection to turbopump (F9) and inlet duct connection to stage, as applicable
	(c) Fuel bleed line connection to fuel bleed valve (F18)
	(d) Fuel turbopump connection to support (below pump volute) (F12)
	(e) Fuel turbopump connection to high-pressure duct (F14)
	(f) Fuel turbopump discharge pressure PF2 static instrumentation port (F15) and line weld (on engines not incorporating MD150 change)
	(g) Fuel turbopump balance piston cavity pressure PF5 instrumentation port (F45) and line weld
	(h) The following leak-test points if turbopump was replaced or if these items were disturbed:
	1 Fuel turbopump interstage pressure PF6 instrumentation port (F10) and line to transducer (on engines not incorporating MD233 change)
	2 Fuel turbopump bearing temperature transducer port PST1 (F11) (on engines not incorporating MD172 change)
	3 Fuel turbopump discharge fluid temperature transducer port PFT1a (F13)
	4 Fuel turbopump balance piston pump pressure PF4 at capped line (F47)
(2) Pump seal leak tests	(a) Fuel turbopump omniseal and GG control valve fuel poppet combined leakage
	(b) Primary seal leakage

Test Required	Item Tested
	(c) Total feed system leakage (uninstalled engines only)
c. Purge system test:	
(1) Flow test	(a) Oxidizer turbine seal purge flow
	(b) Fuel turbine seal purge flow
	(c) Fuel turbopump primary seal purge flow
	(d) GG fuel purge flow
	(e) Total purge system flow (sum of individual flowrates) (uninstalled engines only)
(2) Leak test	(a) Fuel turbopump primary seal purge line weld
	(b) Fuel turbine seal purge line weld
	(c) GG fuel purge line weld
	(d) Fitting between fuel turbopump and primary seal drain check valve
d. Fuel turbine seal purge check valve reverse-leak test	Fuel turbine seal drain line weld (leak test)
e. Fuel turbopump secondary seal leak test	Fuel turbopump secondary seal leakage
f. Fuel turbopump primary seal purge check valve reverse-leak test	Fuel turbopump primary seal drain line (leak test)
g. Gas generator and exhaust system test	(1) Fuel turbine seal leakage
	(2) Fuel turbine exhaust duct connection to oxidizer turbine inlet (G1)
	(3) On engines not incorporating MD237 change, the following instrumentation items:
	(a) OTBV inlet pressure TG8 instrumentation port (G15)
	(b) GG chamber pressure GG1A instrumentation port (G17), and on engines not incorporating MD150, MD280, or MD281 change, instrumentation line weld
	(c) GG chamber pressure GG1 instrumentation port (G18) and line weld
	(4) Fuel turbine inlet manifold connection to STDV hose (G22)
	(5) GG spark igniter cable G4 port A (G23) and cable G3 port B (G30)
	(6) Fuel turbopump connection to turbine exhaust duct (G29)
	(7) GG fuel injector pressure GF4 instrumentation port and line weld (F44)

Test Required	Item Tested
	(8) The following leak-test points if fuel turbopump was replaced or if these items were disturbed:
	(a) Fuel turbine inlet temperature transducer port TGT2a (G20) on engines not incorporating MD237 change
	(b) Fuel turbine inlet pressure TG1a (acceptance) instrumentation port (G19) on engines not incorporating MD136 change
	(c) Fuel turbine inlet pressure TG1 (acceptance) instrumentation port (G21) on engines not incorporating MD136 or MD237 change

NOTE

On engines incorporating MD237 change, former TG1 port (G21) is deleted and former TGT1b port (G31) becomes the new TG1 port.

Test Required	Item Tested
	(d) Fuel turbine inlet temperature transducer port TGT1b (G31) on engines not incorporating MD237 change
	(e) Fuel turbine inlet temperature transducer port TGT1 (G24)
	(f) GG overtemperature transducer GGT1 (G25)
	(9) Fuel turbine inlet pressure TG1 instrumentation port (G31) and line weld (on engines incorporating MD237 change)
	(10) The following leak-test points if exhaust duct was replaced or if these items were disturbed:
	(a) OTBV inlet temperature transducer port TGT6 (G16) (on engines not incorporating MD237 change)
	(b) Fuel turbine exhaust temperature transducer port TGT2 (G26)
	(c) Fuel turbine exhaust pressure TG2 instrumentation port (G27)
	(d) Fuel turbine exhaust drain port (G28)
	(11) STDV drain line connection to STDV (G32) on engines incorporating MD234 change
h. Gas generator equalization line leak test	GG equalization line weld
i. Spark igniter test	GG spark igniters

NOTE

The test requirements in step j are applicable after the exhaust system test plates are removed.

Test Required	Item Tested
j. Pneumatic control system test:	
(1) Leak test with helium control valve energized	(a) OTBV opening control port (P22)
	(b) Fuel bleed valve closing control port (P35)

Test Required	Item Tested
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21)
	(b) GG opening control port (P34)
	(c) Purge control valve inlet line flange (P19)
(3) Leak test of purge line port	GG oxidizer injector pressure GO5 instrumentation port (L40)
k. Flight instrumentation system test:	
(1) Pressure transducer testing	Fuel turbopump interstage PF6, on engines not incorporating MD233, or MD304 change (connector P141)
(2) Temperature transducer testing	(a) Fuel turbopump bearing temperature PST1 (on engines not incorporating MD172 change) (connector P161)
	(b) Fuel turbine inlet temperature TGT1 on engines not incorporating MD263 change (connector P126)
(3) Speed and flow transducer testing	Fuel turbopump speed transducer PFV (connector P112)
(4) Valve position indicator calibration testing (uninstalled engines only)	GG control valve (connector P116) and OTBV (connector P117) position indicators
l. Engine sequence test (hardwire)	Engine valve timing, GG control valve and OTBV operation and position indicators
m. Engine pneumatic system helium usage test	Pneumatic control system

4-28. FUEL TURBOPUMP SPEED TRANSDUCER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Fuel feed system test (leak test)	Transducer seal (measured with flowtester at end of drain tube adjacent to transducer; leakage is not allowable)
b. Flight instrumentation system test (speed and flow transducer testing)	Fuel turbopump speed transducer PFV (connector P112)

4-29. GAS GENERATOR CONTROL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test	(1) GG oxidizer line connection to GG (L28)
	(2) Oxidizer turbopump shaft seal and GG control valve oxidizer poppet combined leakage (and individual leakages, if necessary)
b. Fuel feed system test	(1) GG fuel line connection to GG (F8)
	(2) Fuel turbopump omniseal and GG control valve fuel poppet combined leakage
c. Gas generator and exhaust system test:	
(1) Leak test	(a) GG fuel valve connection to GG injector (F43)
	(b) GG oxidizer valve connection to GG injector (L39)

Test Required	Item Tested
(2) Gas generator oxidizer injector poppet test requirements	(Refer to paragraph 4-32.)
d. Gas generator equalization line leak test	GG equalization line weld

NOTE

The test requirements in steps e through g are applicable after the exhaust system test plates are removed.

Test Required	Item Tested
e. Pneumatic control system test:	
(1) Leak test with helium control valve energized	OTBV opening control port (P22)
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) MOV sequence valve adapter (connection to GG and fast-shutdown valve inlet lines) (P8)
	(b) GG opening control port (P34)
	(c) OTBV closing control port (P21)
	(d) Purge control valve inlet line flange (P19)
	(e) Fast-shutdown valve inlet line flange (P33)
(3) Leak test of purge control valve purge lines (applicable only if oxidizer injector poppet reverse-leak test was performed)	(a) GG oxidizer injector purge in-line flange (P27) if flange was disturbed
	(b) GO5 instrumentation line connection to static-test transducer (on engines not incorporating MD150, MD280, or MD281 change) if connection was disturbed
f. Engine sequence test (hardwire) A minimum of 12 sequence tests must be run (recording at least 6 cycles), to make sure the GG control valve does not exhibit a slowing trend.	Engine valve timing, OTBV operation, and GG control valve operation and position indicator (connector P116)
g. Engine pneumatic system helium usage test	Pneumatic control system
h. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	GG control valve position indicator (connector P116)

4-30. GAS GENERATOR CONTROL VALVE POTENTIOMETER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	GG control valve position indicator potentiometer; connector P116
b. Engine sequence test (Stage telemetry may be used.)	GG control valve potentiometer operation; connector P116

4-31. GAS GENERATOR FUEL LINE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
Fuel feed system test (leak test) (exhaust system test plates not required)	a. GG fuel line connection to GG (F8)
	b. Fuel bleed valve connection to fuel bleed valve adapter (GG fuel line) (F19)
	c. Fuel bleed valve adapter (GG fuel line) connection to fuel high-pressure duct (F20)

4-32. GAS GENERATOR OXIDIZER INJECTOR POPPET POST-INSTALLATION TEST REQUIREMENTS. The post-installation test requirements for the GG oxidizer injector poppet consist of a reverse-leak test of the poppet performed during GG control valve post-installation testing. These test requirements must be applied during GG and exhaust system testing, as indicated in the GG control valve post-installation test requirements (paragraph 4-29).

a. Test requirements in R-3825-1B for GG and exhaust system testing are applicable to poppet reverse-leak testing. The following are additional post-maintenance requirements:

(1) GG and exhaust system pressure at zero.

(2) In-line flange on GG oxidizer purge line (GO5) disconnected or instrumentation line GO5 disconnected at static-test transducer (on engines not incorporating MD150 change).

b. Pressurizing requirements for GG and exhaust system in R-3825-1B are applicable to poppet reverse-leak testing.

c. The following are requirements for measuring poppet reverse leakage:

(1) Pneumatic flowtester used to measure leakage from GG injector at open end of oxidizer purge line or instrumentation line GO5.

(2) Maximum allowable leakage is 1,500 scim, recorded as GG injector poppet reverse leakage.

(3) GG and exhaust system pressure reduced to zero after poppet reverse leakage is measured.

d. The following requirements are applicable after poppet reverse leakage is measured:

(1) Oxidizer purge in-line flange reconnected with new seal installed, and bolts torqued to 19-21 in-lb, or instrumentation line GO5 reconnected to static-test transducer.

(2) Remaining GG control valve post-installation tests performed as detailed by test requirements in paragraph 4-29.

4-32A. GAS GENERATOR OXIDIZER PURGE CHECK VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
Pneumatic control system test (leak test under flow conditions).	GG oxidizer purge line weld and line flange (P27).

4-33. GAS GENERATOR SPARK IGNITER CABLE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. These test requirements are also part of the fuel turbopump post-installation test requirements (paragraph 4-27), which may be used instead of this paragraph if fuel turbopump post-installation testing is also required.

Test Required	Item Tested
a. Gas generator and exhaust system test (leak test).	(1) GG spark igniter cable G4 port A (G23).
	(2) GG spark igniter cable G3 port B (G30).
b. Spark igniter test.	GG spark igniters

NOTE

The test requirements in steps c and d are applicable after the exhaust system test plates are removed.

Test Required	Item Tested
c. Pneumatic control system test:	
(1) Leak test with helium control valve energized.	OTBV opening control port (P22).
(2) Leak test with helium, ignition-phase, and mainstage control valves energized.	(a) OTBV closing control port (P21).
	(b) Purge control valve inlet line flange (P19) if disturbed during testing.
d. Engine sequence test (hardwire).	Engine valve timing and OTBV operation.

4-34. GIMBAL POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. These test requirements apply to installed engines only.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required).	(1) Oxidizer inlet duct connection to turbopump (LI) and/or inlet duct connection to stage, as applicable for connections disturbed.
	(2) LOX BLEED LINE customer connect (SII-stage center engines only).

Test Required	Item Tested
b. Fuel feed system test (leak test) (exhaust system test plates not required)	(1) Fuel inlet duct connection to turbopump (F9) and/or inlet duct connection to stage, as applicable for connections disturbed
	(2) FUEL BLEED LINE customer connect (SII-stage center engines only)
c. Thrust chamber test (leak test)	HYDROGEN TANK PRESSURIZATION customer connect (SII-stage engines only)
d. Oxidizer tank pressurization system leak test	OXIDIZER TANK PRESSURIZATION customer connect (SII-stage center engines only)

4-35. HEAT EXCHANGER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2. On uninstalled engines and stage-installed engines not in a stacked vehicle, these test requirements are also included as part of the oxidizer turbopump post-installation test requirements (paragraph 4-55), which may be used in lieu of this paragraph if oxidizer turbopump post-installation testing is also required.

Test Required	Item Tested
a. Oxidizer feed system test (leak test for SII-stage engines only; exhaust system test plates not required)	Heat exchanger oxidizer inlet pressure HO1 instrumentation port (L23) and line weld
b. Gas generator and exhaust system test	(1) The following leak-test points if these items were disturbed:
	(a) Oxidizer turbopump torque-access cover plate (G4)
	(b) Oxidizer turbopump accessory drive pad connection to turbine exhaust duct (G5)
	(c) Oxidizer turbopump accessory drive pad access plug (if hydraulic pump is not installed) (G6)
	(2) Oxidizer turbopump connection to turbine exhaust duct (heat exchanger) (G7)
	(3) Oxidizer turbine exhaust pressure TG4 instrumentation port (G8) and line weld
	(4) Oxidizer turbine exhaust temperature transducer port TGT4 (G9) if disturbed
	(5) The following leak-test points (on engines not incorporating MD237 change) if these items were disturbed:
	(a) Heat exchanger pressure instrumentation port HG2 (G10)
	(b) Heat exchanger temperature port HGT2 (G11)

NOTE

The test requirements in step c must be selected, as applicable, for the pneumatic control ports disturbed during installation and removal of the exhaust system test plates.

Test Required	Item Tested
c. Pneumatic control system test:	
(1) Leak test with helium control valve energized	OTBV closing control port (P22)

Test Required	Item Tested
(2) Leak test with helium ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21) (b) Purge control valve inlet line flange (P19)
d. Oxidizer tank pressurization system leak test:	
(1) Leak test on all engines	(a) Oxidizer tank pressurization line (b) Heat exchanger outlet flange (L26)
(2) Leak test on engines for SII stage	(a) Heat exchanger antiflood check valve connection to heat exchanger (L24) (b) Bypass line flange connection to antiflood check valve (L25)
(3) Leak test on engines for SIVB stage	(a) Helium inlet line connection to heat exchanger (L24) (b) Bypass line flange blank plate if disturbed (L25)
e. Flight instrumentation system test: (temperature transducer testing)	Oxidizer turbine exhaust TGT4 (on engines not incorporating MD263 or MD355 change) (connector P128)
f. Engine (hardwire) sequence test (applicable after exhaust system test plates are removed)	Engine valve timing and OTBV operation

4-36. HEAT EXCHANGER ANTIFLOOD CHECK VALVE POST-INSTALLATION TEST REQUIREMENTS. The antiflood check valve is installed only on engines for SII stage. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required)	(1) Heat exchanger oxidizer supply line connection to oxidizer high-pressure duct (L12) and/or line weld (2) Heat exchanger oxidizer inlet pressure HO1 instrumentation port (L23) and line weld
b. Oxidizer tank pressurization system leak test	(1) Heat exchanger antiflood check valve connection to heat exchanger (L24) (2) Bypass line flange connection to antiflood check valve (L25)

4-37. HEAT EXCHANGER INLET MANIFOLD FILTER AND ORIFICE POST-INSTALLATION TEST REQUIREMENTS. Removing and installing the heat exchanger inlet manifold filter and orifice as detailed in section III, requires removing the heat exchanger antiflood check valve. The post-installation test requirements for the inlet filter and orifice are identical to post-installation test requirements for the antiflood check valve (paragraph 4-36).

4-38. HELIUM CONTROL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. These test requirements are also part of the helium regulator assembly (pneumatic control package) post-installation test requirements (paragraph 4-40), which may be used instead of this paragraph if helium regulator assembly post-installation testing is also required.

Test Required	Item Tested
a. Pneumatic control system test.	Helium control valve operation
b. Helium supply system mass-loss test (uninstalled engines) or helium supply system pressure-decay test (installed engines)	Helium supply system

Test Required	Item Tested
c. Engine sequence test (hardwire)	Engine valve timing and and valve actuation sequence
d. Engine pneumatic system helium usage test	Pneumatic control system

4-38A. HELIUM CONTROL VALVE FILTER (ENGINES INCORPORATING MD372 CHANGE) POST-INSTALLATION TEST REQUIREMENTS. The post-installation test requirements for the helium control valve filter are identical to post-installation test requirements for the helium control valve (paragraph 4-38).

4-38B. HELIUM TANK EMERGENCY VENT CONTROL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. These test requirements are also part of the helium regulator assembly (pneumatic control package) post-installation test requirements (paragraph 4-40), which may be used instead of this paragraph if helium regulator assembly post-installating testing is also required.

Test Required	Item Tested
a. Pneumatic control system test	Helium tank emergency vent control valve operation
b. Helium supply system mass-loss test (uninstalled engines) or helium supply system pressure-decay test (installed engines)	Helium supply system

4-39. HELIUM COVER AND HELIUM FILL-CHECK VALVE POST-INSTALLATION TEST REQUIREMENTS. Removing and installing the helium cover and helium fill-check valve, as detailed in section III, requires removing the integral hydrogen-helium start tank on which the helium cover and fill-check valve is installed. Post-installation test requirements for the helium cover and fill-check valve are included as part of the start tank post-installation test requirements. (Refer to paragraph 4-44.)

4-40. HELIUM REGULATOR ASSEMBLY (PNEUMATIC CONTROL PACKAGE) POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (flow test) (exhaust system test plates not required)	Oxidizer turbopump intermediate seal purge flow
b. Pneumatic control system test:	
(1) Leak and function test with helium control valve energized	(a) Helium control valve operation
	(b) Mainstage control valve connection to mainstage control valve manifold (P13)(leak test)
	(c) Helium regulator outlet pressure port NN2 (P14) and NN2 line weld (leak test)
	(d) Helium tank pressure NN1 (at pneumatic regulator assembly inlet cover) (P15) (leak test)
	(e) Ignition-phase control valve connection to ignition-phase control valve manifold (P16) (leak test)
	(f) Helium regulator assembly bleed valve control and accumulator line outlet flange (P17) and bleed valve control line weld (leak test)
(2) Leak and function test with helium and ignition-phase control valves energized	(a) Ignition-phase control valve operation
	(b) Ignition-phase control valve connection to ignition-phase control valve manifold (P16) (leak test)

Test Required	Item Tested
(3) Leak and function test with helium, ignition-phase, and mainstage control valves energized	(a) Mainstage control valve operation (b) Mainstage control valve connection to mainstage control valve manifold (P13) (leak test)
(4) Helium tank emergency vent control valve (function test)	Helium tank emergency vent control valve operation
c. Helium supply system mass-loss test (uninstalled engines) or helium supply system pressure-decay test (installed engines)	Helium supply system
d. Flight instrumentation system test (speed and flow transducer testing)	Main oxidizer flowrate transducer POF (connector P111)
e. Engine sequence test (hardwire)	Engine valve timing and valve actuation sequence; ASI valve position indicator switch (connector P120)
f. Engine pneumatic system helium usage sequence test and pneumatic accumulator system test	Pneumatic control system

4-41. HIGH-PRESSURE RELIEF VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. These test requirements are also part of the helium regulator assembly post-installation test requirements (paragraph 4-40), which may be used instead of this paragraph if helium regulator assembly post-installation testing is also required.

Test Required	Item Tested
Helium supply system mass-loss test (uninstalled engines) or helium supply system pressure-decay test (installed engines)	Helium supply system and high-pressure relief valve

4-42. IGNITION DETECTOR PROBE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Thrust chamber test (leak test)	Ignition detector (fusible link) probe flange (G14) if probe was installed in ASI housing
b. Engine power buses energized (Special post-maintenance test requirement applicable to installed engines only; may be satisfied during engine sequence testing.)	Ignition detector probe, circuit, and connector P19 continuity verified when engine-ready indication is obtained and ignition-complete indication is not obtained

4-43. IGNITION-PHASE CONTROL VALVE AND MAINSTAGE CONTROL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. These test requirements are also part of the helium regulator assembly (pneumatic control package) post-installation test requirements (paragraph 4-40), which may be used instead of this paragraph if helium regulator assembly post-installation testing is also required.

Test Required	Item Tested
a. Pneumatic control system test:	
(1) Leak and function test with helium control valve energized	(a) Mainstage control valve connection to mainstage control valve manifold (P13) (leak test)
	(b) Ignition-phase control valve connection to ignition-phase control valve manifold (P16) (leak test)

NOTE

The test requirements in substeps 2 and 3 must be selected, as applicable, for the particular control valve affected by the maintenance task.

Test Required	Item Tested
(2) Leak and function test with helium and ignition-phase control valves energized	(a) Ignition-phase control valve operation
	(b) Ignition-phase control valve connection to ignition-phase control valve manifold (P16) (leak test)
(3) Leak and function test with helium and mainstage control valves energized	(a) Mainstage control valve operation
	(b) Mainstage control valve connection to mainstage control valve manifold (P13) (leak test)
b. Engine sequence test (hardwire)	Engine valve timing and valve actuation sequence
c. Engine pneumatic system helium usage test	Pneumatic control system

4-44. INTEGRAL HYDROGEN HELIUM START TANK POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Start system test (leak test)	(1) Start tank support-and-fill valve connection to start tank (F2)
	(2) Start tank vent-and-relief valve connection to start tank (F3)
	(3) Start tank temperature transducer TFT1 (F4) if port was disturbed
	(4) STDV connection to start tank (F5)
b. Start tank mass-loss test (on uninstalled engines and on installed restart-mission engines)	Start system
c. Start tank pressure-decay test (on installed nonrestart-mission engines)	Start system
d. Gas generator and exhaust system test (leak test)	(1) STDV connection to STDV hose (F42)
	(2) STDV bleed line connection to STDV (G32) (on engines incorporating MD234 change)

Test Required	Item Tested
NOTE The test requirements in step e must be selected, as applicable, for the pneumatic control ports disturbed during installation and removal of the exhaust system test plates.	
e. Pneumatic control system test:	
(1) Leak and function test with helium and ignition-phase control valves energized	(a) STDV position indicator operation (closed)
	(b) OTBV opening control port (P22) (leak test)
	(c) STDV closing control port (P31) (leak test)
(2) Leak and function test with helium, ignition-phase, and STDV control valves energized	(a) STDV control valve connection to adapter (P32) (leak test)
	(b) STDV position indicator operation (open)
	(c) STDV opening control port (P30) leak test
(3) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21)
	(b) Purge control valve inlet line flange (P19)
f. Helium supply system leak test	(1) Helium tank connection to helium cover and fill-check valve (P29)
	(2) The following leak-test points if helium cover was completely removed from engine:
	(a) Helim tank temperature transducer NNT1 (P28)
	(b) Helium inlet line weld and helium tank outlet line weld
	(3) Helium fill-check valve reverse leakage if check valve or cover was replaced
g. (Deleted)	
h. Helium supply system mass-loss test (uninstalled engines) or helium supply system pressure-decay test (installed engines)	Helium supply system
i. Flight instrumentation system test:	
(1) Temperature transducer testing	(a) Start tank gas temperature transducer TFT1 (connector P123)
	(b) Helium tank gas temperature transducer NNT1 (connector P122) if connector was disturbed.
(2) Valve position indicator calibration testing (on uninstalled engines only)	STDV position indicator (connector P118)

Test Required	Item Tested

NOTE

The test requirements in step j and k are applicable after the exhaust system test plates are removed.

Test Required	Item Tested
j. Engine sequence test (hardwire)	Engine valve timing, OTBV and STDV operation, and STDV position indicator (connector P118)
k. Engine pneumatic system helium usage test	Pneumatic control system

4-44A. MAIN FUEL VALVE POSITION INDICATOR POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Flight instrumentation system test (valve position indicator)	MFV potentiometer (connector P114)
b. Engine sequence test (Stage telemetry may be used.)	MFV operation; position indicator potentiometer (connector P114)

4-45. MAIN FUEL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Fuel feed system test (leak test) (exhaust system test plates not required)	MFV upstream flange (F6)
b. Thrust chamber test (leak test)	MFV downstream flange (F41)
c. Pneumatic control system test:	
(1) Leak test with helium control valve energized	MFV closing control port (P26)
(2) Leak test with helium and ignition-phase control valves energized	(a) MFV opening control port (P23)
	(b) MFV sequence valve inlet port (P24)
	(c) MFV sequence valve outlet port (P25)
d. Engine sequence test (hardwire)	Engine valve timing, MFV operation, and MFV position indicator (connector P114)
e. Engine pneumatic system helium usage test	Pneumatic control system
f. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	MFV position indicator (connector P114)

4-45A. MAIN OXIDIZER VALVE POSITION INDICATOR POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	MOV potentiometer (connector P115)
b. Engine sequence test (Stage telemetry may be used.)	MOV operation; position indicator potentiometer (connector P115)

4-46. MAIN OXIDIZER VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required)	(1) MOV upstream flange (L21)
	(2) ASI valve flange connection to MOV (L22)

NOTE

Items 3 through 8 are applicable to installed SII-stage center engines only, if the oxidizer high-pressure duct was removed.

Test Required	Item Tested
	(3) Heat exchanger oxidizer supply line connection to oxidizer high-pressure duct (L12)
	(4) Oxidizer turbopump discharge pressure PO3 instrumentation port (L13) and line weld
	(5) Oxidizer flowmeter flange (L14)
	(6) Oxidizer bleed valve connection to oxidizer high-pressure duct (L17)

Test Required	Item Tested
	(7) Oxidizer turbopump connection to oxidizer high-pressure duct (L10)
	(8) The following leak test points if these items were disturbed:
	(a) Oxidizer turbopump discharge fluid-temperature transducer POT3 (L15)
	(b) Blank plate on oxidizer high-pressure duct (L20)
b. Thrust chamber test (leak test)	(1) ASI valve connection to ASI oxidizer line (L32)
	(2) MOV downstream flange (L33)
	(3) Mainstage OK pressure switch No. 2 (L38) and pressure switch adapter to oxidizer injector dome flange (on engines incorporating MD180 change)
	(4) Oxidizer injector purge check valve connection to MOV (P36)
	(5) Oxidizer injector purge check valve reverse leakage
c. Gas generator equalization line leak test	GG equalization line weld
d. Main oxidizer valve sequence control valve lip seal leak test (applicable only if valve was replaced)	Sequence control valve lip seal leakage
e. Pneumatic control system test:	
(1) Leak test with helium control valve energized	(a) MOV closing control port (P3)
	(b) ASI valve closing control port (P12)
(2) Leak test with helium and ignition-phase control valves energized	(a) MOV sequence valve inlet port (P6)
	(b) ASI valve opening control port (P11)
(3) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) MOV second-stage actuator (opening control) port (P2)
	(b) MOV connection to MOV sequence valve (P4)
	(c) MOV first-stage actuator (opening control) port (sequence valve pre-stage inlet) (P5)
	(d) MOV sequence valve adapter (connection to GG and fast-shutdown valve inlet lines) (P8)
	(e) MOV sequence valve adapter (connection to OTBV closing control line) (P9)
f. Mainstage OK pressure switch test (on engines incorporating MD180 change) (function test only)	Mainstage OK pressure switch No. 2 and connector P26
g. Flight instrumentation system test:	
(1) Temperature transducer testing (on SII-stage center engines only)	Oxidizer turbopump discharge temperature POT3 (connector P125)

Test Required	Item Tested
(2) Speed and flow transducer testing (on SII-stage center engines only).	Main oxidizer flowrate POF (connector P111) and (on engines not incorporating MD150, MD280, or MD281 change) POFa (connector J111A).
(3) Valve position indicator calibration testing (on uninstalled engines only).	MOV position indicator (connector P115).
h. Engine sequence test (hardwire).	Engine valve timing, MOV operation, and MOV (connector P115) and ASI valve (connector P120) position indicators.
i. Engine pneumatic system helium usage test.	Pneumatic control system.

4-47. MAINSTAGE OK PRESSURE SWITCH POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Thrust chamber test (leak test).	(1) Mainstage OK pressure switch No. 1 (L37).
	(2) Mainstage OK pressure switch No. 2 (L38).
b. Mainstage OK pressure switch test.	Mainstage OK pressure switches No. 1 and No. 2.

4-47A. MIXTURE RATIO CONTROL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Pneumatic control system test: leak test with helium control valve energized.	MRCV pneumatic inlet line and port (P38).
b. Engine sequence test (hardwire).	MRCV timing and voltage change.
c. Oxidizer feed system test (leak test) (exhaust system test plates not required.)	(1) MRCV outlet flange connection to turbopump (L5).
	(2) MRCV outlet pressure instrumentation port PO9 (L6) and line weld.
	(3) MRCV inlet pressure instrumentation port PO8 (L9) and line weld.
	(4) MRCV inlet flange connection to turbopump (L8).
	(5) MRCV shaft seal for leakage.
d. Engine pneumatic system helium usage test.	Pneumatic control system.

4-47B. MIXTURE RATIO CONTROL VALVE POSITION INDICATOR POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
Engine sequence test (hardwire).	MRCV operation; verify presence of a continuous recorded trace.

4-47C. MIXTURE RATIO CONTROL VALVE SOLENOID VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Engine sequence test (hardwire).	MRCV timing and voltage change.
b. Engine pneumatic system helium usage test.	Pneumatic control system.

4-48. OXIDIZER BLEED LINE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required.)	Oxidizer bleed line connections at bleed valve (L16) and customer connect.

NOTE

The test requirements in steps b through h are the start tank support-and-fill valve post-installation test requirements.

Test Required	Item Tested
b. Start system test (leak test).	(1) Start tank initial fill line weld.
	(2) Start tank pressure TF1 instrumentation port (F1) and line weld.
	(3) Start tank support-and-fill valve connection to start tank (F2).
c. Start tank emergency vent valve test (on engines incorporating MD320 or MD351 change).	Start tank emergency vent valve.
d. Start system weld integrity test requirements.	(Refer to paragraph 4-76.)
e. Start tank mass-loss test (on uninstalled engines and on installed restart-mission engines).	Start system.
f. Start tank pressure-decay test (on installed nonrestart-mission engines).	Start system.
g. Fuel turbopump primary seal drain check valve reverse-leak test (on engines incorporating MD320 or MD351 change).	Emergency vent valve drain line weld (leak test of line to tee in fuel turbopump primary seal drain line).
h. Thrust chamber test (leak test).	Start tank gaseous (hydrogen) refill line connection to forward fuel manifold (F34).

4-49. OXIDIZER BLEED VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required).	(1) Oxidizer bleed line connection to bleed valve (L16).
	(2) Oxidizer bleed valve connection to oxidizer high-pressure duct (L17).
	(3) Oxidizer bleed valve--oxidizer temperature transducer GOT2 (L18).
	(4) Oxidizer bleed valve capped port GO2 (L19) (on engines not incorporating MD237 change).
	(5) GG oxidizer line connection to GG (L28) or line weld, as applicable.
	(6) Oxidizer bleed valve leakage.

Test Required	Item Tested
b. Pneumatic control system test (leak and function test with helium control valve energized).	Oxidizer bleed valve closing control port (P1).
c. Flight instrumentation system test (temperature transducer testing).	Oxidizer bleed valve--oxidizer temperature transducer GOT2 (connector P159).
d. Engine sequence test (hardwire).	Engine valve timing, valve actuation sequence, and oxidizer bleed valve position indicator operation (connector P132).
e. Engine pneumatic system helium usage test.	Pneumatic control system.

4-50. OXIDIZER FLOWMETER AND FLOW STRAIGHTENER POST-INSTALLATION TEST REQUIREMENTS. Post-installation test requirements for the oxidizer flowmeter and flow straightener are identical to post-installation test requirements for the oxidizer high-pressure duct in which the flowmeter and flow straightener are installed. (Refer to paragraph 4-51.)

4-50A. OXIDIZER FLOW TRANSDUCER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
Flight instrumentation system test (speed and flow transducer testing).	Main oxidizer flowrate transducer POF (connector P111) and (on engines not incorporating MD150, MD280, or MD281 change) POFa (connector P111a).

4-51. OXIDIZER HIGH-PRESSURE DUCT POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required).	(1) Oxidizer turbopump connection to oxidizer high-pressure duct (L10).
	(2) Heat exchanger oxidizer supply line connection to oxidizer high-pressure duct (L12) (engines for SII stage only).

Test Required	Item Tested
	(3) Oxidizer turbopump discharge pressure PO3 instrumentation port (L13) and line weld
	(4) Oxidizer flowmeter flange (L14) if disturbed
	(5) Oxidizer bleed valve connection to oxidizer high-pressure duct (L17)
	(6) MOV upstream flange (L21)
	(7) The following leak-test points if these items were disturbed:
	(a) Oxidizer turbopump discharge fluid-temperature transducer POT3 (L15)
	(b) Blank plate on oxidizer high-pressure duct (L20)
b. Thrust chamber test (leak test)	Mainstage OK pressure switch No. 2 (L38) (on engines incorporating MD180 change)
c. Mainstage OK pressure switch test (on engines incorporating MD180 change) (function test only)	Mainstage OK pressure switch No. 2
d. Flight instrumentation system test:	
(1) Speed and flow transducer testing	Main oxidizer flowrate transducer POF (connector P111) and (on engines not incorporating MD150, MD280, or MD281 change) POFa (connector J111A)
(2) Temperature transducer testing	Oxidizer turbopump discharge temperature POT3 (connector P125)

4-52. OXIDIZER INJECTOR PURGE CHECK VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2.

Test Required	Item Tested
a. Thrust chamber test (leak test)	(1) Oxidizer injector purge check valve connection to MOV (P36)
	(2) Oxidizer injector purge check valve (reverse leakage)
b. Pneumatic control system test (leak test of purge control valve purge lines)	(1) Oxidizer injector purge line weld
	(2) Oxidizer injector purge pressure tap CN1 (P10)

4-53. OXIDIZER INLET DUCT POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2.

Test Required	Item Tested
Oxidizer feed system test (leak test) (exhaust system test plates not required)	Oxidizer inlet duct connection to turbopump (L1), and inlet duct connection to stage

4-54. OXIDIZER TURBINE BYPASS VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2. These test requirements are also part of the fuel turbine exhaust duct and fuel turbopump post-installation test requirements (paragraphs 4-26 and 4-27), which may be used in lieu of this paragraph if fuel turbine exhaust duct or fuel turbopump post-installation testing is also required.

Test Required	Item Tested
a. Pneumatic control system test:	
(1) Leak test with helium control valve energized	OTBV opening control port (P22)
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	OTBV closing control port (P21)
b. Engine sequence test (hardwire)	Engine valve timing, valve actuation sequence, OTBV operation, and OTBV position indicator (connector P117)
c. Engine pneumatic system helium usage test	Pneumatic control system
d. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	OTBV position indicator (connector P117)

4-54A. OXIDIZER TURBINE BYPASS VALVE POSITION INDICATOR POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	OTBV potentiometer (connector P117)
b. Engine sequence test (Stage telemetry may be used.)	OTBV operation; position indicator potentiometer (connector P117)

4-55. OXIDIZER TURBOPUMP POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test:	
(1) Leak test	(a) Oxidizer inlet duct connection to turbopump (L1) and inlet duct connection to stage
	(b) MRCV (or PU valve) outlet flange (L5) and inlet flange (L8) connections to turbopump
	(c) MRCV (or PU valve) outlet pressure PO9 (L6) and inlet pressure PO8 (L9) instrumentation ports and line welds
	(d) Oxidizer turbopump connection to oxidizer high-pressure duct (L10)
	(e) Oxidizer turbopump discharge pressure PO2 static instrumentation port (L11) and line weld (on engines not incorporating MD150, MD280, MD281, or MD237 change)
	(f) Heat exchanger oxidizer inlet pressure HO1 instrumentation port (L23) and line weld (applicable to uninstalled engines for SII stage and to installed SII-stage engines in stacked-vehicle configuration)
	(g) Oxidizer turbopump bearing coolant pressure PO7 instrumentation line weld (L41) (on engines not incorporating MD269, MD282, MD296, MD313, or MD315 change)
	(h) Oxidizer bleed line connection to oxidizer bleed valve (L16)

Test Required	Item Tested
(2) Pump seal leak tests	(a) Intermediate seal purge flow
	(b) Intermediate seal leakage
	(c) Oxidizer turbopump shaft seal and GG control valve oxidizer poppet combined leakage (and individual leakages, if necessary)
	(d) Primary seal leakage
	(e) Total feed system leakage (uninstalled engines only)
b. Purge system test:	
(1) Flow test	Oxidizer turbine seal purge flow
(2) Leak test	Oxidizer turbine seal purge line weld
c. Oxidizer turbine seal purge check valve reverse-leak test	Turbine seal drain line weld
d. Oxidizer turbopump primary seal drain line leak test	(1) Primary seal drain line weld
	(2) Primary seal cavity pressure PO6 instrumentation line weld
e. Gas generator and exhaust system test	(1) Oxidizer turbine seal leakage
	(2) Fuel turbine exhaust duct connection to oxidizer turbine inlet (G1)
	(3) Oxidizer turbine inlet pressure TG3 instrumentation port (G3) and line weld
	(4) Oxidizer turbopump torque-access cover plate (G4) if disturbed
	(5) Oxidizer turbopump accessory drive pad connection to turbine exhaust duct (G5), and if hydraulic pump is not installed, accessory drive pad access plug (G6) if disturbed
	(6) Oxidizer turbopump connection to turbine exhaust duct (G7)
	(7) Oxidizer turbine inlet temperature transducer port TGT3 (G2) if disturbed
	(8) Oxidizer turbine exhaust temperature transducer port TGT4 (G9) if disturbed
	(9) Oxidizer turbine exhaust pressure TG4 instrumentation port (G8) and line weld
	(10) On engines not incorporating MD237 change, the following transducer ports if these items were disturbed:
	(a) Heat exchanger pressure HG2 instrumentation port (G10)
	(b) Heat exchanger temperature HGT2 port (G11)
eA. Helium supply system weld integrity test requirements.	(Refer to paragraph 4-75.)
f. Pneumatic control system test:	
(1) (Deleted)	

NOTE

The remaining test requirements in step f must be selected, as applicable, for the pneumatic control ports disturbed during installation and removal of the exhaust system test plates.

Test Required	Item Tested
(1A) Leak test with helium control valve energized	(aA) Oxidizer turbopump intermediate seal purge line weld

Test Required	Item Tested
	(b) OTBV opening control port (P22)
	(c) The following ports, if blocking plates were installed during oxidizer feed system test:
	(1) Oxidizer bleed valve closing control port (P1)
	(2) Pneumatic accumulator inlet line flange (P20) (primary FI package)
	(3) Fuel bleed valve closing control port (P35)
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P22)
	(b) Purge control valve inlet line flange (P19)
g. Oxidizer tank pressurization system leak test (applicable only on uninstalled engines for SII stage and on installed SII-stage engines not in stacked-vehicle configuration):	
(1) Leak test on all engines	Heat exchanger outlet flange (L26)
(2) Leak test on engines for SII stage only	(a) Heat exchanger antiflood check valve connection to heat exchanger (L24)
	(b) Bypass line flange connection to antiflood check valve (L25)
h. MRCV (or PU valve) test	MRCV (function test); connectors P36A and P119A or PU valve (function test); connectors P36 and P119

NOTE

The test requirements in step i are applicable after the exhaust system test plates are removed.

Test Required	Item Tested
i. Engine sequence test (hardwire).	Engine valve timing and OTBV operation.
j. Flight instrumentation system test:	Engine valve timing.
(1) Temperature transducer testing.	(a) Oxidizer turbine inlet TGT3 (on engines not incorporating MD263 change) (connector P127).
	(b) Oxidizer turbine exhaust TGT4 (on engines not incorporating MD263 or MD355 change) (connector P128) if disturbed.
	(c) Oxidizer turbopump bearing coolant POT4 (connector P162).
(2) Speed and flow transducer testing.	Oxidizer turbopump speed transducer POV (connector P113).
(3) Valve position indicator calibration testing (on uninstalled engines only).	MRCV position indicator (connector P119A) or PU valve position indicator (connector P119).
k. Start system weld integrity test requirements.	*(Refer to paragraph 4-76.)*

4-55A. PRESSURIZING VALVES (SPARK IGNITER CABLE, ELECTRICAL CONTROL ASSEMBLY, AUXILIARY AND PRIMARY FLIGHT INSTRUMENTATION PACKAGES) POST-INSTALLATION TEST REQUIREMENTS. *Details for determining post-maintenance test* requirements are contained in paragraph 4-2.

Test Required	Item Tested
Leak test of SIC, ECA, and auxiliary and primary FI packages, as applicable.	Pressurizing valve.

4-56. PRIMARY FLIGHT INSTRUMENTATION PACKAGE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2. Post-installation test requirements for individual transducers are in paragraph 4-16.

Test Required	Item Tested
a. Flight instrumentation system test:	

NOTE

If a transducer was replaced, the initial voltage checkout requirements in paragraph 4-74 must be performed for that transducer instead of the requirements in substep 1.

Test Required	Item Tested
(1) Pressure transducer testing	(a) Thrust chamber CG1 (b) GG chamber GG1 or (on engines incorporating MD237 change) fuel turbine inlet TG1 (c) Helium tank NN1 (d) Fuel turbopump discharge PF3 (e) Oxidizer turbopump discharge PO3 (f) Start tank TF1 (g) Fuel turbopump interstage pressure PF6 (on engines not incorporating MD233 change) or thrust chamber (low-range) pressure (on engines incorporating MD304 change); connectors P102 and P103
(2) Temperature transducer testing	Primary FI package temperature transducer; connector P103
(3) Valve position indicator calibration testing (uninstalled engines only)	Connector P101 or P104: (a) MFV (b) MOV (c) GG control valve (d) OTBV (e) STDV (f) PU valve

Test Required	Item Tested
b. Oxidizer feed system test (leak test) (exhaust system test plates not required)	Oxidizer turbopump discharge pressure PO3 instrumentation line weld
c. Fuel feed system test (leak test) (exhaust system test plates not required)	Fuel turbopump discharge pressure PF3 instrumentation line weld
d. Thrust chamber test (leak test)	Thrust chamber pressure CG1 instrumentation line weld
e. Gas generator and exhaust system test (leak test)	On engines not incorporating MD237 change, GG chamber pressure GG1 instrumentation line weld, or on engines incorporating MD237 change, fuel turbine inlet pressure TG1 instrumentation line weld

NOTE

The test requirements in steps f and g are applicable after the exhaust system test plates are removed.

f. Pneumatic control system test

NOTE

The test requirements in substeps 1 and 2 must be selected, as applicable, for the pneumatic control ports disturbed by installation and removal of the exhaust system test plates.

Test Required	Item Tested
(1) Leak test with helium control valve energized	(a) Pneumatic accumulator inlet line flange (P20) (primary FI package) (b) OTBV opening control port (P22)
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21) (b) Purge control valve inlet line flange (P19)

Test Required	Item Tested
g. Helium supply system leak test	Helium tank pressure NN1 instrumentation line weld
h. Helium supply system weld integrity test requirements	(Refer to paragraph 4-75.)
i. Start system test (leak test)	Start tank pressure TF1 instrumentation line weld
j. Start system weld integrity test requirements	(Refer to paragraph 4-76.)
k. Engine (hardwire) sequence test (applicable after exhaust system test plates are removed)	Engine valve timing, valve actuation sequence, and OTBV operation

4-57. PROPELLANT UTILIZATION VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required)	(1) PU valve outlet flange connection to turbopump (L5)
	(2) PU valve outlet pressure PO9 instrumentation port (L6) and line weld
	(3) PU valve connection to PU valve actuator (L7) if valve was replaced or connection disturbed
	(4) PU valve inlet flange connection to turbopump (L8)
	(5) PU valve inlet pressure PO8 instrumentation port (L9) and line weld
b. Propellant utilization valve test	PU valve (function test); connectors P36 and P119
c. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	PU valve position indicator (connector P119)

4-58. PURGE CONTROL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Pneumatic control system test:	
(1) Leak test with helium control valve energized	(a) Purge control valve diaphragm leakage
	(b) Control line weld
	(c) Outlet line flange (P18)
(2) Leak test with helium and mainstage control valves energized	(a) Purge control valve seat leakage
	(b) Inlet line flange (P19)
b. Engine pneumatic system helium usage test	Pneumatic control system

4-59. PURGE RESTRICTOR AND CHECK VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Purge system test:	
(1) Flow test:	

NOTE

The test requirements in substeps a through e on uninstalled engines, and a through d on installed engines, are applicable regardless of which purge check valve or restrictor was removed and installed.

Test Required	Item Tested
	(a) Oxidizer turbine seal purge flow.
	(b) Fuel turbine seal purge flow.
	(c) Fuel turbopump primary seal purge flow.
	(d) GG fuel purge flow.
	(e) Total purge system flow (sum of individual flowrates) (uninstalled engines only).
(2) Leak test of line welds affected by maintenance task.	(a) Oxidizer turbine seal purge line welds.
	(b) Fuel turbine seal purge line welds.
	(c) Fuel turbopump primary seal purge line welds.
	(d) GG fuel purge line welds.

NOTE

The test requirements in steps b through d must be selected as applicable to the restrictor or check valve being tested.

Test Required	Item Tested
b. Fuel turbine seal purge check valve reverse-leak test.	Fuel turbine seal purge check valve.
c. Oxidizer turbine seal purge check valve reverse-leak test.	Oxidizer turbine seal purge check valve.
d. Fuel turbopump primary seal purge check valve reverse-leak test.	Fuel turbopump primary seal purge check valve.
dA. Fuel turbopump primary seal drain check valve reverse-flow test.	Fuel turbopump primary seal drain check valve.
dB. Fuel turbopump primary seal drain check valve test:	
(1) Flow test.	Fuel turbopump primary seal drain check valve forward leakage and flow.
(2) Leak test of line welds affected by maintenance task.	Fuel turbopump primary seal drain line welds.
dC. Oxidizer feed system test (test plates not required):	
(1) Flow test.	Oxidizer turbopump intermediate seal purge flow.
(2) Leak test of line welds affected by maintenance task.	Oxidizer turbopump intermediate seal purge line welds.
e. Gas generator and exhaust system test.	GG fuel purge check valve (reverse-leak test).

NOTE

The test requirements in steps f and g are applicable after the exhaust system test plates are removed.

Test Required	Item Tested
f. Pneumatic control system test:	
(1) Leak test with helium control valve energized.	OTBV opening control port (P22).
(2) Leak test with helium, ignition-phase, and mainstage control valves energized.	(a) OTBV closing control port (P21).
	(b) Purge control valve inlet line flange (P19).
g. Engine sequence test (hardwire).	Engine valve timing and OTBV operation.

4-59A. REDUNDANT PURGE CHECK VALVE POST-MAINTENANCE TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Pneumatic control system leak test.	Purge control valve outlet flange joint and purge line welds.
b. Redundant purge check valve reverse leakage test.	

4-60. START TANK DISCHARGE VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Start system test (leak test)	STDV connection to start tank (F5)
b. Start tank mass-loss test (uninstalled engines and installed restart-mission engines)	Start system
c. Start tank pressure-decay test (installed nonrestart-mission engines)	Start system
d. (Deleted)	
e. Gas generator and exhaust system test (leak test)	(1) STDV connection to STDV hose (F42)
	(2) STDV bleed line connection to STDV (G32) (on engines incorporating MD234 change)

NOTE

The test requirements in step f must be selected, as applicable, for the pneumatic control ports disturbed during installation and removal of the exhaust system test plates.

Test Required	Item Tested
f. Pneumatic control system test:	
(1) Leak and function test with helium and ignition-phase control valves energized	(a) STDV position indicator operation (closed)
	(b) OTBV opening control port (P22) (leak test)
	(c) STDV closing control port (P31) (leak test)
(2) Leak and function test with helium, ignition-phase, and STDV control valves energized	(a) STDV position indicator operation (open)
	(b) STDV control valve connection to adapter (P32) (leak test)
	(c) STDV opening control port (P30) (leak test)
	(d) The following leak-test points if the valve was replaced or if these items were disturbed:
	1 Blank plate on STDV control port
	2 STDV potentiometer connection to STDV (Maximum allowable leakage is one scim.)
(3) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21)
	(b) Purge control valve inlet line flange (P19)
g. Flight instrumentation system test:	
(1) Valve position indicator calibration testing (on uninstalled engines only)	STDV position indicator (connector P118)
(2) Temperature transducer testing	Start tank gas temperature transducer TFT1 (connector P123)

NOTE

The test requirements in step h are applicable after the exhaust system test plates are removed

Test Required	Item Tested
h. Engine sequence test (hardwire)	Engine valve timing, OTBV and STDV operation, and STDV position indicator (connector P118)
i. Engine pneumatic system helium usage test	Pneumatic control system

4-61. START TANK DISCHARGE VALVE CONTROL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Pneumatic control system test (leak and function test with helium, ignition-phase, and STDV control valves energized)	(1) STDV control valve operation (2) STDV control valve connection to adapter (P32)
b. Engine sequence test (hardwire)	Engine valve timing, valve actuation sequence, and STDV operation
c. Engine pneumatic system helium usage test	Pneumatic control system

4-62. START TANK DISCHARGE VALVE CONTROL VALVE ADAPTER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Pneumatic control system test:	
(1) Leak and function test with helium and ignition-phase control valves energized	(a) STDV control valve operation (b) STDV closing control port (P31)
(2) Leak test with helium, ignition-phase and STDV control valves energized	(a) STDV opening control port (P30) (b) STDV control valve connection to adapter (P32)
b. Engine sequence test (hardwire)	Engine valve timing, valve actuation sequence, and STDV operation
c. Engine pneumatic system helium usage test	Pneumatic control system

4-63. START TANK DISCHARGE VALVE HOSE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Gas generator and exhaust system test (leak test)	(1) Fuel turbine inlet manifold connection to STDV hose (G22) (2) STDV connection to STDV hose (F42)

NOTE

The test requirements in steps b and c are applicable after removal of the exhaust system test plates.

Test Required	Item Tested
b. Pneumatic control system test:	
(1) Leak test with helium control valve energized	OTBV opening control port (P22)
(2) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) OTBV closing control port (P21) (b) Purge control valve inlet line flange (P19)
c. Engine sequence test (hardwire)	Engine valve timing and OTBV operation

4-64. START TANK DISCHARGE VALVE POTENTIOMETER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are in paragraph 4-2.

Test Required	Item Tested
a. Pneumatic control system test:	
(1) Function test with helium and ignition-phase control valves energized	STDV position indicator operation (closed)

Test Required	Item Tested
(2) Leak and function test with helium, ignition-phase, and STDV control valves energized	(a) STDV position indicator operation (open) (b) STDV potentiometer connection to STDV (leak test) (Maximum allowable leakage is one scim.)
b. Flight instrumentation system test (valve position indicator calibration testing on uninstalled engines only)	STDV potentiometer (connector P118)
c. Engine sequence test (Stage telemetry may be used.)	STDV operation; position indicator potentiometer (connector P118)

4-65. START TANK EMERGENCY VENT VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determing post-maintenance test requirements are contained in paragraph 4-2.

Test Required	Item Tested
a. Start system test (leak test)	Start tank emergency vent valve connection to start tank support-and-fill valve (F52)
b. Start tank emergency vent valve test	Start tank emergency vent valve
c. Start tank mass-loss test (on uninstalled engines and on installed restart-mission engines)	Start system
d. Start tank pressure-decay test (on installed nonrestart mission engines)	Start system
e. Fuel turbopump primary seal drain check valve reverse-leak test	Emergency vent valve drain line weld (leak test of line to tee in fuel turbopump primary seal drain line)

4-66. START TANK LIQUID REFILL CHECK VALVE MANIFOLD POST-INSTALLATION TEST REQUIREMENTS. Post-installation test requirements for the start tank liquid refill check valve manifold are identical to post-installation test requirements for the start tank liquid refill line in which the check valve is installed. (Refer to paragraph 4-67.)

4-67. START TANK LIQUID REFILL LINE POST-INSTALLATION TEST REQUIREMENTS. These test requirements are applicable only on restart-mission engines. Details for determining post-maintenance test requirements are contained in paragraph 4-2.

Test Required	Item Tested
a. Start system test (leak test)	Start tank liquid refill line weld downstream from check valve
b. Start system weld integrity test requirements	(Refer to paragraph 4-76.)
c. Start tank mass-loss test	Start system
d. Thrust chamber test (leak test)	Start tank liquid refill line flange on ASI fuel line (F50) or refill line weld, as applicable to maintenance task performed

4-68. START TANK SUPPORT-AND-FILL VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2. If the support-and-fill valve was removed to provide access for removal and/or installation of the oxidizer bleed line, the post-installation test requirements for the oxidizer bleed line (paragraph 4-48) may be used in lieu of the test requirements in this paragraph.

Test Required	Item Tested
a. Start system test (leak test)	(1) Start tank initial fill line weld (2) Start tank pressure TF1 instrumentation port (F1) and line weld (3) Start tank support-and-fill valve connection to start tank (F2) (4) Start tank emergency vent valve connection to support-and-fill valve (F52) if disturbed (on engines incorporating MD320 or MD351 change) (5) Blank plate on support-and-fill valve (F52) (on engines not incorporating MD320 or MD351 change) if valve was replaced or plate was disturbed
b. Start tank emergency vent valve test (on engines incorporating MD320 or MD351 change)	Start tank emergency vent valve
c. Start system weld integrity test requirements	(Refer to paragraph 4-76.)
d. Start tank mass-loss test (on uninstalled engines and on installed restart-mission engines)	Start system
e. Start tank pressure-decay test (on installed nonrestart-mission engines)	Start system
f. Fuel turbopump primary seal drain check valve reverse-leak test (on engines incorporating MD320 or MD351 change)	Emergency vent valve drain line weld (leak test of line to tee in fuel turbopump primary seal drain line)
g. Thrust chamber test (leak test)	(1) Start tank gaseous (hydrogen) refill line connection to forward fuel manifold (F34) (2) Start tank gaseous (hydrogen) refill line weld near support-and-fill valve (F35) if line was cut and if weld was not leak tested prior to installation of valve and line on engine.

4-69. START TANK VENT-AND-RELIEF VALVE POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2. The test requirements of this paragraph must be selected, as applicable, for the disconnections and/or line cuts performed during the maintenance task.

Test Required	Item Tested
a. Start system test (leak test)	(1) Start tank vent-and-relief valve connection to start tank (F3) (2) Start tank vent valve control line weld if line was cut.

Test Required	Item Tested
	(3) START TANK VENT VALVE CONTROL customer connect if line was disconnected at stage interface.
b. Start tank mass-loss test (on uninstalled engines and on installed restart-mission engines)	Start system
c. Start tank pressure-decay test (on installed nonrestart-mission engines)	Start system
d. Start tank vent-and-relief valve drain leak test	(1) Start tank vent-and-relief valve drain line weld if line was cut.
	(2) START TANK VENT & RELIEF VALVE DRAIN customer connect if line was disconnected at stage interface.

4-70. TEMPERATURE TRANSDUCER POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2. The test requirements in this paragraph must be selected, as applicable, for the individual temperature transducers affected by the maintenance task.

Test Required	Item Tested
a. Flight instrumentation system test (temperature transducer testing; requirements must be selected, as applicable, for transducer to be tested)	(1) Fuel injection CFT2 (connector P131)
	(2) Thrust chamber jacket No. 1 (CS1; connector P129) and No. 2 (CS1a; connector P130)
	(3) Fuel bleed valve GFT1 (connector P158)
	(4) Oxidizer bleed valve GOT2 (connector P159)
	(5) Heat exchanger oxidizer outlet HOT2 (on engines for SII stage only) (connector P157)
	(6) Helium tank gas NNT1 (connector P122)
	(7) Fuel turbopump discharge PFT1 (connector P124)
	(8) Oxidizer turbopump discharge POT3 (connector P125)
	(9) Start tank gas TFT1 (connector P123)
	(10) On engines not incorporating MD263 change, the following transducers:
	(a) Fuel turbine inlet TGT1 (connector P126)
	(b) Oxidizer turbine inlet TGT3 (connector P127)
	(11) Oxidizer turbine exhaust TGT4 (on engines not incorporating MD263 or MD355 change) (connector P128)

Test Required	Item Tested
NOTE The test requirements in steps b through d are applicable to transducer TFT1.	
b. Start system test (leak test)	Start tank temperature transducer TFT1
c. Start tank mass-loss test (uninstalled engines and installed restart-mission engines)	Start system
d. Start tank pressure-decay test (installed nonrestart-mission engines)	Start system
NOTE The test requirements in step e are applicable to transducers GOT2 and POT3.	
e. Oxidizer feed system test (leak test) (exhaust system test plates not required)	(1) Oxidizer bleed valve--oxidizer temperature transducer GOT2 (L18) (2) Oxidizer turbopump discharge fluid-temperature transducer POT3 (L15)
NOTE The test requirements in step f are applicable to transducers GFT1 and PFT1.	
f. Fuel feed system test (leak test) (exhaust system test plates not required)	(1) Fuel bleed valve--fuel temperature transducer GFT1 (F17) (2) Fuel turbopump discharge fluid-temperature transducer PFT1 (F7)
NOTE The test requirements in step g are applicable to transducers CFT2 and CFT2a.	
g. Thrust chamber test (leak test)	(1) Main fuel injection temperature transducer CFT2 (F31) (2) Main fuel injection temperature (control) transducer CFT2a (on engines not incorporating MD262 change)
NOTE The test requirements in steps h and i are applicable to transducer NNT1.	
h. Helium supply system leak test	Helium tank temperature transducer NNT1 (P28)
i. Helium supply system mass-loss test (uninstalled engines) or helium supply system pressure-decay test (installed engines)	Helium supply system
NOTE The test requirements in step j are applicable to transducer HOT2 on engines for use in the SII stage.	
j. Oxidizer tank pressurization system leak test	Heat exchanger outlet temperature transducer HOT2 (L27)

4-71. THRUST CHAMBER INJECTOR POST-INSTALLATION TEST REQUIREMENTS. Details for determining post-maintenance test requirements are contained in paragraph 4-2.

Test Required	Item Tested
a. Oxidizer feed system test (leak test) (exhaust system test plates not required)	(1) Oxidizer inlet duct connection to turbopump (L1) and/or inlet duct connection to stage, as applicable for connections disturbed
	(2) Oxidizer turbopump connection to oxidizer high-pressure duct (L10)
	(3) Heat exchanger oxidizer supply line connection to oxidizer high-pressure duct (L12) (engines for SII stage only)
	(4) Oxidizer turbopump discharge pressure PO3 instrumentation port (L13) and line weld
	(5) Oxidizer bleed valve connection to oxidizer high-pressure duct (L17)
	(6) MOV upstream flange (L21)
	(7) LOX BLEED LINE customer connect (SII-stage center engines only)
b. Fuel feed system test (leak test) (exhaust system test plates not required)	(1) Fuel inlet duct connection to turbopump (F9) and/or inlet duct connection to stage, as applicable for connections disturbed
	(2) FUEL BLEED LINE customer connect (SII-stage center engines only)
c. Thrust chamber test (leak test)	(1) Thrust chamber injector connection to thrust chamber forward fuel manifold (F30)
	(2) Flange seal between ASI and thrust chamber injector (L35), if disturbed
	(3) Upper and lower ASI fuel line flange connections (F49)
	(4) ASI valve connection to ASI oxidizer line (L32)
	(5) MOV downstream flange (L33)
	(6) Oxidizer injector purge check valve connection to MOV (P36)
	(7) Mainstage OK pressure switches No. 1 (L37) and No. 2 (L38)
	(8) HYDROGEN TANK PRESSURIZATION customer connect (SII-stage engines only)
	(9) Main fuel injection temperature transducer CFT2 (F31)
	(9A) Main fuel injection temperature control transducer CFT2a (F51) on engines not incorporating MD262 change
	(10) Main fuel injection pressure CF2 instrumentation port (F23) and line weld
	(11) Main oxidizer injection pressure CO3 instrumentation port (L34) and line weld
	(12) The following leak-test points on engines not incorporating MD237 change:
	(a) Thrust chamber pressure CG1 instrumentation port (G12) and line weld

Test Required	Item Tested
	(b) Thrust chamber pressure CG1A static instrumentation port (G13) and (on engines not incorporating MD150, MD280, or MD281 change) line weld
d. Start system test (leak test)	Start tank vent-and-relief valve connection to start tank (F3)
e. Start tank mass-loss test (on uninstalled engines and on installed restart-mission engines)	Start system
f. Start tank pressure-decay test (on installed nonrestart-mission engines)	Start system
g. Gas generator equalization line leak test	GG equalization line weld
h. Oxidizer tank pressurization system leak test (applicable only to SII-stage center engines)	OXIDIZER TANK PRESSURIZATION customer connect
i. Spark igniter test	ASI and GG spark igniters; ECA connector P2
j. Mainstage OK pressure switch test	Mainstage OK pressure switches No. 1 and No. 2; ECA connector P3
k. Pneumatic control system test:	
(1) Leak test with helium control valve energized	(a) MOV closing control port (P3)
	(b) ASI valve closing control port (P12)
	(c) Purge control valve control line weld
	(d) Purge control valve outlet line weld
(2) Leak test with helium and ignition-phase control valves energized	(a) MOV sequence valve inlet port (P6)
	(b) ASI valve opening control port (P11)
(3) Leak test with helium, ignition-phase, and mainstage control valves energized	(a) MOV second-stage actuator (opening control) port (P2)
	(b) MOV first-stage actuator (opening control) port (P5) (sequence valve pre-stage inlet)
	(c) MOV sequence valve adapter (connection to GG and fast-shutdown valve inlet lines) (P8)
	(d) MOV sequence valve adapter (connection to OTBV closing control line) (P9)
	(e) Purge control valve inlet line weld
(4) Function test and component-test-circuit checkout	(a) Helium tank emergency vent control valve operation; ECA connectors P1 and P3
	(b) Helium, ignition-phase, STDV, and mainstage control valve operation; ECA connector P2

Test Required	Item Tested
l. (Deleted)	
m. Flight instrumentation system test:	
(1) Temperature transducer testing	(a) Main fuel injection CFT2 (connector P131)
	(b) Oxidizer turbopump discharge POT3 (connector P125)
	(c) ECA temperature transducer No. 1 and No. 2; ECA connector P2
(2) Speed and flow transducer testing	Main oxidizer flowrate transducer POF (connector P111) and (on engines not incorporating MD150, MD280, or MD281 change) POFa (connector J111a)
(3) Valve position indicator calibration testing (on uninstalled engines only)	MOV position indicator (connector P115)
n. Engine sequence test (hardwire)	Engine valve timing, valve actuation sequence, electrical control system operation, and MOV (connector P115) and ASI valve (connector P120) position indicator operation
o. Engine pneumatic system helium usage test	Pneumatic control system

4-72. SPECIAL POST-MAINTENANCE TEST REQUIREMENTS.

4-73. Special test requirements include tests that are performed after completion of maintenance tasks but are not performed during scheduled engine checkout and therefore are not in R-3825-1B.

4-74. INITIAL VOLTAGE CHECKOUT OF PRESSURE TRANSDUCERS AFTER REPLACEMENT IN THE FIELD. When an FI pressure transducer is replaced in the field, an initial voltage checkout is required. The transducer output voltage readings must be recorded in the Engine Log Book in place of the values that were listed for the replaced transducer. The new voltage values become a reference for use in subsequent voltage checkout tests of the new transducer. The output voltage readings obtained during the initial checkout must be within the allowable voltage ranges listed in figure 4-2.

4-75. HELIUM SUPPLY SYSTEM WELD INTEGRITY TEST REQUIREMENTS. These requirements are applicable only when a line exposed to helium tank pressure is cut and welded.

a. Pressurize engine helium tank to 1,400-1,600 psig and leak test line weld affected by maintenance task. Leakage is not allowable.

WARNING

While the helium tank is pressurized in step b, personnel must stand behind adequate safety barriers or at a safe distance from the engine. Failure to observe safety requirements can result in injury.

b. Pressurize tank to 2,800-3,000 psig for 2 minutes or longer; then depressurize.

NOTE

Helium tank proof pressure is 5,800 (+0, -100) psig at +70° ±20° F.

c. Repeat step a; then depressurize.

Transducer Range (psia)	Allowable Output Voltage Range (vdc)		
	Initial Output at Ambient Pressure	Low Calibrate (20%)	High Calibrate (80%)
0-50	1. 150 to 1. 850	2. 150 to 2. 850	>5 to >5
0-100	0. 500 to 1. 000	1. 500 to 2. 000	4. 500 to 5. 000
0-200	0. 150 to 0. 600	1. 150 to 1. 600	4. 150 to 4. 600
0-500	-0. 050 to +0. 350	0. 950 to 1. 350	3. 950 to 4. 350
0-750	-0. 100 to +0. 300	0. 900 to 1. 300	3. 900 to 4. 300
0-1, 000	-0. 125 to +0. 275	0. 875 to 1. 275	3. 875 to 4. 275
0-1, 500	-0. 150 to +0. 250	0. 850 to 1. 250	3. 850 to 4. 250
0-2, 000	-0. 163 to +0. 237	0. 837 to 1. 237	3. 837 to 4. 237
0-3, 500	-0. 178 to +0. 222	0. 822 to 1. 222	3. 822 to 4. 222
0-5, 000	-0. 185 to +0. 215	0. 815 to 1. 215	3. 815 to 4. 215

Figure 4-2. Pressure Transducer Allowable Output Voltage Ranges

4-76. START SYSTEM WELD INTEGRITY TEST REQUIREMENTS. These requirements are applicable only when a line exposed to start tank pressure is cut and welded.

CAUTION

The start tank vent-and-relief valve vent line customer connect must be open when the start system is pressurized. If pressure in start tank vent-and-relief valve vent line exceeds control line pressure by more than 30 psig, the control diaphragm in the vent-and-relief valve can be damaged.

a. Pressurize start tank to 500 ±20 psig and leak test line weld affected by maintenance task. Leakage is not allowable.

WARNING

While the start tank is pressurized in step b, personnel must stand behind adequate safety barriers or at a safe distance from the engine. Failure to observe safety requirements can result in injury.

NOTE

Gas flow through the vent-and-relief valve can be expected as the tank pressure exceeds 1,200 psig. This flow may be limited by setting the regulator pressure toward the lower side of the specified limits.

b. Pressurize start tank to 1,200-1,400 psig for 2 minutes or longer; then depressurize.

NOTE

Start tank proof pressure is 1,850 (+0, -5) psig at 70° ±20° F.

c. Repeat step a; then depressurize.

4-77. MISCELLANEOUS POST-MAINTENANCE TEST REQUIREMENTS.

4-78. Figure 4-3 lists the system tests and applicable portions of tests required to restore engine system integrity following the installation (or reconnection or welding) of connections, lines, and engine components, that are not provided with individual post-installation test requirement paragraphs in this section. An "X" under a system test title in the test requirement column denotes applicability of that test to the corresponding engine component, connection, or line. Test requirements include tests that are necessary because of the disturbance of connections during the performance of other post-maintenance tests. Unless otherwise specified, test sequence must be determined by the user. In all cases, the user must apply these test requirements and the requirements of R-3825-1B to the particular needs created by a maintenance task. Where applicable and to more easily determine specific test requirements and items to be tested, the requirements in figure 4-3 may be correlated with related test requirement paragraphs in this section.

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																	
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
ASI Lower Fuel Line (paragraph 4-13)																		
1. Upper fuel line flange										X								
2. Thrust chamber fuel inlet manifold flange										X								
3. Start tank liquid refill line flange										X								
ASI Valve (paragraph 4-14)																		
1. MOV flange			X															
2. Outlet flange (oxidizer line)										X								
3. Control line flange								X			X							
Calips Checkout Line																	X(a)	
ECA Spark Igniter Connectors (not including disconnection of P1, P2, or P3) (paragraph 4-18)											X(s)					X		
Fast-Shutdown Valve (paragraph 4-19)																		
1. Inlet line flange								X			X							
2. Control line weld								X										
Fuel Bleed Valve (paragraph 4-21)																		
1. Adapter (GG fuel line) flange				X														
2. Bleed line flange				X														
3. Control line flange								X			X							
Fuel Flowmeter (paragraph 4-22)																		
1. Main fuel flowrate transducer PFF														X				
2. Redundant flowrate transducer PFFa (on engines not incorporating MD150, MD280, or MD281 change)														X				

(a) Leak test only.
(s) Hardwire for spark rates only.

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 1 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																	
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
Fuel High-Pressure Duct (paragraph 4-23)																		
1. Turbopump flange				X														
2. Flowmeter flanges (2)				X														
3. *MFV flange*				X														
4. GG fuel line (bleed valve adapter) flange				X														
Fuel Jacket Purge Line and Check Valve (paragraph 4-25)										X								
Fuel Turbine Exhaust Duct (turbopump flange) (paragraph 4-26)							X	X(b)			X(b)							
Fuel Turbopump (paragraph 4-27)																		
1. Inlet duct flange				X														
2. High-pressure duct flange				X														
3. Turbine exhaust duct flange							X	X(b)			X(b)							
4. *STDV hose flange (fuel inlet manifold)*							X	X(b)			X(b)							
5. Primary seal purge line					X			X(b)			X(b)							
6. Turbine seal purge line					X			X(b)			X(b)							
7. Primary seal drain line (See fuel turbopump primary seal drain line and check valve.)																		
8. Turbine seal drain line						X(a)(c)												
Fuel Turbopump Bearing Temperature Transducer PST1 (on engines not incorporating MD172 change)				X										X				
Fuel Turbopump Interstage Pressure Transducer PF6 (on engines not incorporating MD233 change)				X										X				

(a) Leak test only
(b) Required to test OTBV control ports disturbed by exhaust system test plate installation.
(c) Fuel turbine seal purge check valve reverse-leak test

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 2 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																		
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
Fuel Turbopump Primary Seal Drain Line and Check Valve																		
1. Line from turbopump to check valve (upstream side)						X(a)(d)												
2. Line from check valve (downstream side) to customer connect						X(a)(e)												
GG Control Valve (paragraph 4-29)																		
1. GG fuel and oxidizer valve connections to GG injector							X	X(b)			X(b)							
2. Fuel line flange				X														
3. Oxidizer line flange			X															
4. Equalization line weld																		X(f)
5. Control line flange								X			X							
GG Equalization Line																		X(f)
GG Fuel Line (fuel bleed valve adapter) (paragraph 4-31)																		
1. GG control valve flange				X														
2. Fuel high-pressure duct flange				X														
3. Fuel bleed valve flange				X														
GG Injector																		
1. Fuel injector purge line					X			X(b)			X(b)							
2. Oxidizer injector purge line								X										
3. Spark igniter ports							X	X(b)			X(b)					X		
GG Oxidizer Line (See also oxidizer bleed valve.)			X															

(a) Leak test only
(b) Required to test OTBV control ports disturbed by exhaust system test plate installation.
(d) Fuel turbopump primary seal purge check valve reverse-leak test
(e) Fuel turbopump primary seal drain check valve reverse-leak test
(f) GG equalization line leak test

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 3 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																	
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
GG Oxidizer Purge Line, Flange, and Check Valve																		
1. Purge line welds and in-line flange (seal)								X										
2. Check valve						X(h)		X										
Heat Exchanger (oxidizer turbine exhaust duct) (paragraph 4-35)																		
1. Turbopump flange							X	X(b)			X(b)							
2. Antiflood check valve flange (engines for SII stage only)																		X(g)
3. Helium inlet line flange (engines for SIVB stage only)																		X(g)
4. Oxidizer tank pressurization line flange																		X(g)
5. Bypass line weld (engines for SII stage only)																		X(g)
6. Oxidizer turbopump torque access and accessory drive pad covers							X	X(b)			X(b)							
Heat Exchanger Antiflood Check Valve (engines for SII stage only) (paragraph 4-36)																		
1. Oxidizer supply line weld			X															
2. Bypass line flange																		X(g)
3. Heat exchanger flange																		X(g)
Heat Exchanger Bypass Line (engines for SII stage only)																		X(g)
Heat Exchanger Helium Inlet Line (engines for SIVB stage only)																		X(g)
Heat Exchanger Oxidizer Supply Line (engines for SII stage only)			X															
Helium Regulator Assembly (paragraph 4-40)																		
1. Inlet (line) cover flange								X	X(j)									
2. Outlet flange (accumulator line)								X										

(b) Required to test OTBV control ports disturbed by exhaust system test plate installation.
(g) Oxidizer tank pressurization system leak test
(h) GG oxidizer purge check valve reverse-leak test
(j) Helium supply system mass-loss test (uninstalled engines) or pressure-decay test (installed engines)

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 4 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
	Post-Maintenance Test Requirements																	
Helium Regulator Assembly (cont)																		
3. Bleed valve control line								X			X							
4. Oxidizer turbopump intermediate seal purge line			X (k)					X (a)										
Helium Tank Fill Line									X (i)									
Helium Tank Outlet Line									X (i) (j) (l)									
Hydrogen Tank Pressurization Line										X								
Ignition-Phase Control Valve (paragraph 4-43)																		
1. Manifold connection to valve								X			X							
2. Normally open control lines from manifold to:																		
a. Fast-shutdown valve (control line weld)								X										
b. ASI valve (closing flange)								X			X							
c. MFV (closing flange)								X			X							
3. Normally closed control lines from manifold to.																		
a. ASI valve (opening flange)								X			X							
b. MOV sequence control valve (inlet flange)								X			X							
c. MOV sequence control lines from MOV to.								X			X							
(1) Fast-shutdown valve (inlet flange)								X			X							
(2) GG control valve (control flange)								X			X							
(3) OTBV (closing control flange)								X			X							

(a) Leak test only
(i) Helium supply system leak test
(j) Helium supply system mass-loss test (uninstalled engines) or pressure-decay test (installed engines)
(k) Flow test only
(l) Weld integrity test requirements are applicable if line was welded after stage acceptance test.

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 5 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																	
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
Ignition-Phase Control Valve (cont)																		
d. MFV (opening flange)								X			X							
e. MFV sequence valve (inlet flange)								X			X							
f. MFV sequence control line to STDV control valve								X			X							
Instrumentation Pressure-Sensing Lines (primary and auxiliary FI systems and, on engines not incorporating MD150 change, static-test instrumentation)																		
1. CF2 (main fuel injection)--auxiliary and (on engines not incorporating MD237 change) static test										X								
2. CG1 (thrust chamber)--primary and (on engines not incorporating MD304 change) static test										X								
3. CG1a (thrust chamber)--static test										X								
4. CO3 (main oxidizer injection)--auxiliary										X								
5. GF4 (GG fuel injector)--auxiliary and static test							X	X(b)			X(b)							
6. GG1 (GG chamber) on engines not incorporating MD237 change--primary							X	X(b)			X(b)							
7. GG1a (GG chamber) on engines not incorporating MD237 change--static test							X	X(b)			X(b)							
8. GO5 (GG oxidizer injector)--auxiliary and static test								X										
9. HO1 (heat exchanger oxidizer inlet) on engines for SII stage only--auxiliary			X															
10. IG1 (ASI chamber) on engines not incorporating MD192, MD246, MD328, MD329, MD332, or MD344 change--static test										X								

(b) Required to test OTBV control ports disturbed by exhaust system test plate installation.

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 6 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																	
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
Instrumentation Pressure-Sensing Lines (cont)																		
11. NN1 (helium tank pressure)--primary, static test, and (on engines incorporating MD269, MD282, MD296, MD313, or MD315 change) auxiliary (redundant)									X[i][l]									
12. NN2 (helium regulator outlet)--auxiliary and static test								X										
13. PF2 (fuel turbopump discharge)--static test				X														
14. PF3 (fuel turbopump discharge)--primary				X														
15. PF5 (fuel turbopump balance piston cavity)--auxiliary				X														
16. PF6 (fuel turbopump interstage) on engines not incorporating MD233 change--primary				X														
17. PO2 (oxidizer turbopump discharge)																		
a. On engines not incorporating MD237 change, separate PO2 static test line			X															
b. On engines incorporating MD237 change, PO2 static test line from tee in PO3 line			X															
18. PO3 (oxidizer turbopump discharge)--primary and (on engines incorporating MD237 change) static test (PO2 line)			X															
19. PO6 (oxidizer turbopump primary seal cavity)--auxiliary and static test						X[m]												
20. PO7 (oxidizer turbopump bearing coolant) on engines not incorporating MD269, MD282, MD296, MD313, or MD315 change--auxiliary and static test			X															
21. PO8 (PU or MRCV valve inlet)--auxiliary			X															
22. PO9 (PU or MRCV valve outlet)--auxiliary			X															

(i) Helium supply system leak test
(l) Weld integrity test requirements are applicable if line was welded after stage acceptance test.
(m) Oxidizer turbopump primary seal drain line leak test

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 7 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																	
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
Instrumentation Pressure-Sensing Lines (cont)																		
23. TF1 (start tank pressure)--primary, static test, and (on engines incorporating MD269, MD282, MD296, MD313, or MD315 change) auxiliary (redundant)	X[a]	X[1]																
24. TG1 (fuel turbine inlet) on engines incorporating MD237 change--primary							X	X[b]			X[b]							
25. TG3 (oxidizer turbine inlet)--auxiliary							X	X[b]			X[b]							
26. TG4 (oxidizer turbine exhaust)--auxiliary and static test							X	X[b]			X[b]							
Mainstage Control Valve (paragraph 4-43)																		
1. Manifold connection to valve								X			X							
2. Normally open control lines from manifold to:																		
a. MOV (closing flange)								X			X							
b. OTBV (opening flange)								X			X							
c. Purge control valve (control line weld)								X										
3. Normally closed control line from manifold to MOV opening control flanges (2)								X			X							
Mainstage OK Pressure Switches (paragraph 4-47)																		
1. Switch-adapter-thrust chamber connection										X								
2. Calips checkout line and connections																	X[a]	
MFV (paragraph 4-45)																		
1. High-pressure duct (valve upstream) flange				X														
2. Thrust chamber fuel inlet manifold (valve downstream) flange										X								
3. Sequence valve inlet and outlet flanges								X			X							
4. Control line flanges								X			X							

(a) Leak test only
(b) Required to test OTBV control ports disturbed by exhaust system test plate installation.
(1) Weld integrity test requirements are applicable if line was welded after stage acceptance test.

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 8 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements: Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
MOV (paragraph 4-46)																		
1. High-pressure duct (valve upstream) flange			X															
2. Thrust chamber dome (valve downstream) flange										X								
3. ASI valve flange			X															
4. Oxidizer injector purge check valve connection										X								
5. GG equalization line weld																		X(f)
6. Thermal-compensating orifice check valve											X							
7. Sequence valve flanges								X			X							
8. Control line flanges								X			X							
Mixture Ratio Control Valve (paragraph 4-47A)																		
1. Pneumatic inlet line flange								X										
2. Inlet and outlet flanges (turbopump)			X															
OTBV Pneumatic Control Line Flanges (paragraph 4-54)								X			X							
Oxidizer Bleed Valve (paragraph 4-49)																		
1. High-pressure duct flange			X															
2. GG oxidizer line weld (or if bleed valve/oxidizer line integral assembly has been installed, GG oxidizer inlet flange)			X															
3. Bleed line flange			X															
4. Control line flange								X			X							
Oxidizer Flowmeter (paragraph 4-50)																		
1. Main oxidizer flowrate transducer POF														X				
2. Redundant flowrate transducer POFa (on engines not incorporating MD150 change)														X				
Oxidizer High-Pressure Duct (paragraph 4-51)																		
1. Turbopump flange			X															

(f) GG equalization line leak test

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 9 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
Oxidizer High-Pressure Duct (cont)																		
2. Flowmeter flanges (2)			X															
3. MOV flange			X															
4. Bleed valve flange			X															
5. Heat exchanger oxidizer supply line flange (engines for SII stage only)			X															
Oxidizer Injector Purge Line and Check Valve (paragraph 4-52)																		
1. Purge line to upstream side of check valve								X										
2. Pressure tap CN1								X										
3. MOV (check valve downstream) flange										X								
Oxidizer Tank Pressurization Line																		X(g)
Oxidizer Turbine Exhaust Duct (See heat exchanger.)																		
Oxidizer Turbopump (paragraph 4-55)																		
1. Inlet duct flange			X															
2. PU valve inlet and outlet flanges			X															
3. High-pressure duct flange			X															
4. Turbine exhaust duct flange							X	X(b)			X([illegible])							
5. Intermediate seal purge line			X(k)					X(a)										
6. Turbine seal purge line					X			X(b)			X(b)							
7. Primary seal drain line						X(m)												
8. Turbine seal drain line						X(a)(n)												

(a) Leak test only
(b) Required to test OTBV control ports disturbed by exhaust system test plate installation.
(g) Oxidizer tank pressurization system leak test
(k) Flow test only
(m) Oxidizer turbopump primary seal drain line leak test
(n) Oxidizer turbine seal purge check valve reverse-leak test

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 10 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																	
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
Oxidizer Turbopump Intermediate Seal Purge Check Valve			X(k)			X(o)		X(a)										
Pneumatic Accumulator Line and Flange (on primary FI package)								X										
PU Valve (paragraph 4-57)																		
1. Inlet and outlet flanges (turbopump)			X															
2. Valve connection to actuator housing			X															
Purge Control Valve (paragraph 4-58)																		
1. Inlet line flange								X										
2. Outlet line flange								X										
3. Control line weld								X										
Purge Manifold System Line (paragraph 4-59)					X			X(b)			X(b)							
Start Tank Emergency Vent Valve (paragraph 4-65)																		
1. Support-and-fill valve flange	X	X(q)(p)																
2. Vent line weld						X(a)(e)												
Start Tank Emergency Vent Line (to tee in fuel turbopump primary seal drain line)						X(a)(e)												
Start Tank Gaseous Refill Line																		
1. Thrust chamber forward fuel manifold flange										X								
2. Line weld (test applicable on restart-mission engines only)										X								
Start Tank Initial Fill Line	X																	

(a) Leak test only
(b) Required to test OTBV control ports disturbed by exhaust system test plate installation.
(e) Fuel turbopump primary seal drain check valve reverse leak test
(k) Flow test only
(o) Oxidizer turbopump intermediate seal purge check valve reverse-leak test (applicable to uninstalled engines only)
(p) Start system mass-loss test (uninstalled engines and installed restart-mission engines) or pressure-decay test (installed nonrestart-mission engines)
(q) Start tank emergency vent valve test

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 11 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
Start Tank Liquid Refill Line and Check Valve (paragraph 4-67)																		
1. ASI lower fuel line flange										X								
2. Check valve (upstream side) weld										X								
3. Line from check valve (downstream side weld) to TF1 instrumentation port on start tank support-and-fill valve	X	X(1)																
Start Tank Support-and-Fill Valve (paragraph 4-68)																		
1. Start tank flange	X	X(p)																
2. Emergency vent valve flange	X	X(p)																
3. Initial fill line weld	X																	
4. Gaseous refill line weld (test applicable to restart-mission engines only)										X								
5. Liquid refill line weld	X	X(1)																
Start Tank Vent-and-Relief Valve (paragraph 4-69)																		
1. Start tank flange	X	X(p)																
2. Drain line weld																		X(r)
3. Control line weld	X																	
Start Tank Vent-and-Relief Valve Drain Line																		X(r)
Start Tank Vent Valve Control Line	X																	

(1) Weld integrity test requirements are applicable if line was welded after stage acceptance test.
(p) Start system mass-loss test (uninstalled engines and installed restart-mission engines) or pressure-decay test (installed nonrestart-mission engines)
(r) Start tank vent-and-relief valve drain leak test

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 12 of 13)

Engine Components, Connections, and Lines Affected by Maintenance Task	Post-Maintenance Test Requirements																	
	Start System Test	Start Tank Tests	Oxidizer Feed System Test	Fuel Feed System Test	Purge System Test	Check Valve and Pump Seal Tests	Gas Generator and Exhaust System Test	Pneumatic Control System Test	Helium Supply System Tests	Thrust Chamber Test	Engine Sequence Test	Pneumatic System Helium Usage Test	Propellant Utilization Valve Test	Flight Instrumentation System Test	Electrical Resistance-to-Ground Test	Spark Igniter Test	Mainstage OK Pressure Switch Test	Other Tests
STDV (paragraph 4-60)																		
1. Start tank flange	X	X(p)																
2. Hose flange							X	X(b)			X(b)							
3. Potentiometer connection								X			X							
4. Control line flanges								X			X							
STDV Control Valve (paragraph 4-61)																		
1. Adapter connection								X			X							
2. Pneumatic inlet line											X							
STDV Control Valve Adapter (paragraph 4-62)																		
1. Control valve connection								X			X							
2. Control lines								X			X							
STDV Hose (paragraph 4-63)																		
1. STDV flange							X	X(b)			X(b)							
2. Fuel turbine inlet manifold flange							X	X(b)			X(b)							

(b) Required to test OTBV control ports disturbed by exhaust system test plate installation.
(p) Start system mass-loss test (uninstalled engines and installed restart-mission engines) or pressure-decay test (installed nonrestart-mission engines)

Figure 4-3. Miscellaneous Post-Maintenance Test Requirements (Sheet 13 of 13)

SECTION V

PREPARATION OF COMPONENTS HANDLER EQUIPMENT FOR USE

WARNING

THE FOLLOWING GROUND SUPPORT EQUIPMENT MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

G4071, Engine Components Installer
G4072, Engine Components Installer
9026251, Engine Components Installer Set
9026252, Engine Components Installer Set

5-1. SCOPE. This section provides procedures for preparing for use Engine Components Installers G4071 and G4072 and engine components installer sets 9026251 and 9026252. This section does not provide the capability of determining which of the included procedures are required for an individual component removal and/or installation. This information is found in the component removal and installation section (section III). Therefore, to effectively utilize the information in this section, users need perform only those procedures required by the applicable component removal and/or installation procedures found in section III.

5-2. GENERAL INFORMATION.

5-3. Preparing the installers and installer sets for use involves selecting, transporting into the stage, and assembling the installer parts into a configuration designed to accomplish the required task. Assembling the installer parts within the stage requires careful manipulation if injury to personnel and damage to stage or equipment are to be avoided. Cautions and warnings are given wherever a potentially hazardous condition is known to exist. Adequate precautionary data is provided for hazards that are the result of the characteristics of the components installer. No claim is made of similar coverage for hazards caused by stage configuration or limitations. Where cognizance of such stage hazards has been obtained, cautions and warnings are incorporated in the affected procedure. An example of this differentiation is the included precaution against overloading SII-stage heat shields, whereas limitations of the stage work platform, since not obtained, are not noted. To make sure that all safety precautions are taken, personnel performing these tasks must be made aware of all stage safety requirements. The lateral loading of the components installer, when installed, is limited to 0.25g maximum load; consequently, this equipment must be used with the stage vertical and stationary.

5-4. LOADING AND UNLOADING G4071 AND G4072 STOWAGE CARTS.

5-5. The stowage cart contains all parts of the installers. Since individual tasks do not require use of all parts, knowledge of the task to be performed is essential if unnecessary unloading of the cart is to be avoided. To aid in preventing unnecessary unloading, each of the assembly tasks found in this section contains a figure listing the parts of the installer that are required and the shelf on which the part is stored. Shelves are arbitrarily numbered from the bottom up. Shelf 1 is below the sliding portions of the lowermost visible shelf. When the task involves a large number of parts, the figure recommends an area within the stage for temporary placement prior to the assembly procedure. Hinges, slide-bolts, and handles permit shelf 5 to be folded or removed for access to shelf 4 on the G4071 stowage cart. Parts are held in place through use of form-fitting wooden blocks, straps, clamps, or ball-lock pins, or a combination of these. Sheet-metal clamps incorporate a lock device that requires only 1/4-turn to lock or unlock. Compliance with the following will aid in accomplishing efficient loading or unloading of the cart:

a. Position stowage cart in an area that provides a minimum clearance of 4 feet on all sides and a minimum overhead clearance of 3 feet.

b. Lock wheels of stowage cart prior to loading and unloading.

c. Refer to specific procedure for parts required to perform task and remove only those parts. Parts are listed in the recommended order of removal from the cart.

WARNING

Sliding shelves do not incorporate stops to prevent their removal from the cart. Pulling a shelf fully out without proper support will cause the shelf to fall; injury to personnel and damage to equipment could result.

d. Partially pull sliding shelves out to remove components. Locks prevent the shelf from sliding out during movement of cart. Remove locks to pull shelf out and replace them when shelf is pushed in. See figure 5-1 for proper assembly of lock. Do not pull shelves all the way out unless removal of shelf from cart is desired.

Figure 5-1. Shelf Lock

e. If shelf on which boom is stored is difficult to move, loosen the 4 clamps that secure boom.

f. While handling track sections, protect track ends from damage by covering them with protective cushioning material and take care to prevent nicks in track rails.

g. The G4071 stowage cart has 2 sliding shelves that contain numerous small parts. For proper stowage of parts on these shelves, see figure 5-2.

5-6. TRACK SUPPORT (SII STAGE).

5-7. The track support provides a platform for support of the track where stage structure is not available. The support surrounds engine position 5 and is suspended from stage structure. Installation of the support is necessary prior to assembly of track around any of the five engine positions, since it supports a portion of all track installations.

5-8. INSTALLING TRACK SUPPORT. Installing the track support requires personnel to stand and temporarily place installer parts on stage heat shield protective pads. Heat shield limitations require that loads be limited to a maximum of 400 pounds per quadrant (including bridge sections) and lateral forces be kept to a minimum. Bumping or holding onto heat shield support struts is not permitted. Whenever possible, the loads must be applied to the track support structure rather than the heat shield. To aid in calculating weight applied to the heat shield, the procedures give weights of parts exceeding 50 pounds.

WARNING

Exceeding 400 pounds per quadrant, applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

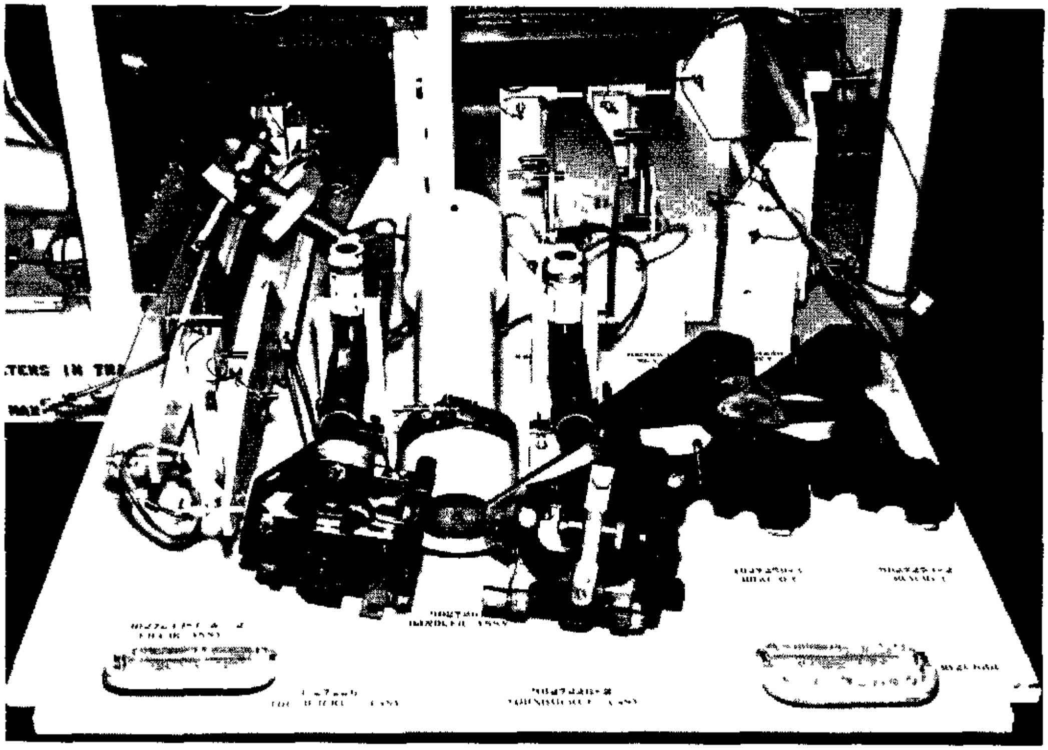
Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

a. Obtain a flexible steel tape, 12 feet long (minimum).

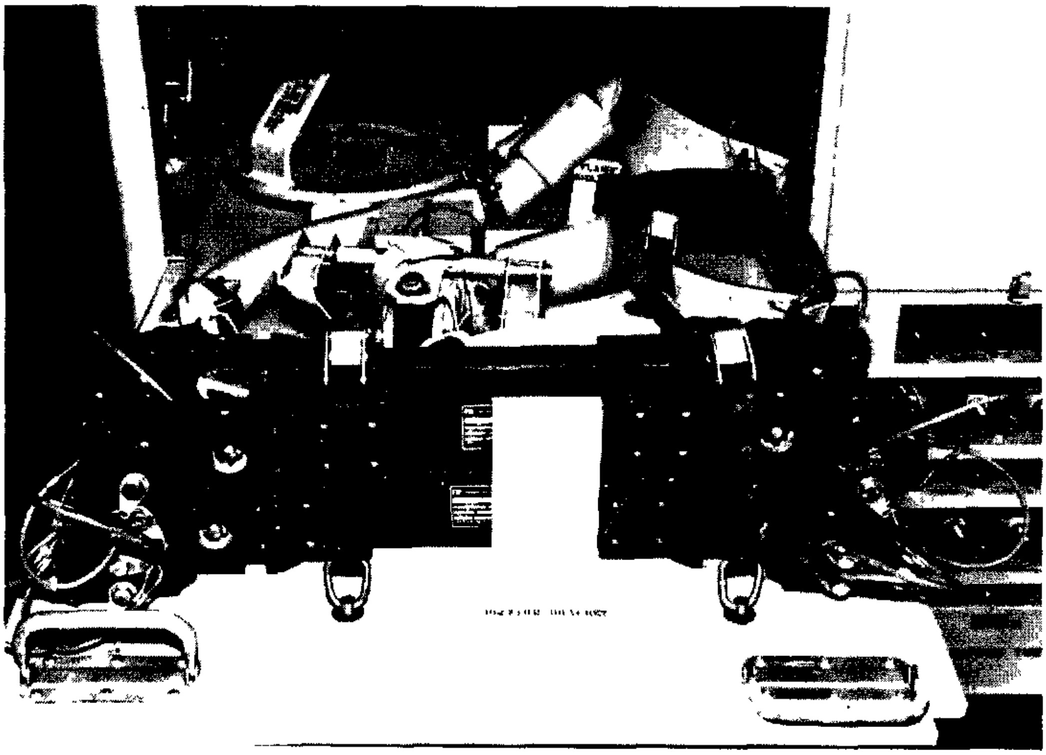
b. Obtain Engine Components Installer G4071 parts listed in figure 5-3 and 4 hoists G7-8215-8 (stage). (Refer to paragraph 5-4 for information on unloading stowage cart.)

c. Attach bracket assemblies 9027182, 9027182-11, and 9027182-21 to stage thrust structure, in locations shown in figure 5-4, as follows:

(1) Remove bolts that secure one clamp to bracket.



SHELF 2



SHELF 3

J2-3-1-78

Figure 5-2. Proper Storage of Miscellaneous Parts of G4071

(2) Loosen bolts that secure other clamp to bracket.

(3) Center bracket assembly over beams, and position clamps with a minimum gap to bulkhead and install bolts removed in substep 1. Torque bolts to 110 ±10 in-lb.

d. Extend struts 9027178 and 9027178-11 to maximum length.

e. With end of strut containing right-hand thread up, attach one strut 9027178 to each hanger on inboard brackets with captive ball-lock pins. Take care not to bump or otherwise cause struts to move, since they can strike and damage engine.

f. With end of strut containing right-hand thread up, attach one strut 9027178-11 to each hanger on outboard brackets with captive ball-lock pins.

g. Install a protective pad on the lower 1/3 of each stage strut supporting the heat shield.

h. Position platform 9027190 on heat shield protective pad (stage) between engine positions 1 and 2, with hangers up and notch in platform straddling the 2 inboard stage struts. (Platform weighs 96 pounds.)

i. Lift platform 9027190 and aline hangers with rod ends of 2 adjacent inboard struts and 2 adjacent outboard struts, and secure platform with captive ball-lock pins.

j. Connect and adjust stage hoist cable as shown in figure 5-5.

k. Install 3 remaining platforms 9027190 between engine positions 2 and 3, 3 and 4, and 4 and 1 as in steps h through j.

l. Center one beam (boltheads up) between each 2 platforms and aline slots with boltholes in platform arms. (See figure 5-6.) Install captive bolts fingertight. (Each beam weighs 52 pounds.)

m. Level each platform by adjusting height of platform to dimension shown in figure 5-7. Mark cover (not illustrated) protecting strut. Do not impression-stamp. After leveling, secure strut rod ends by torquing nuts to 75-100 in-lb.

NOTE

Any lateral movement of platforms after alinement negates leveling.

n. Maintaining platforms level (step m), torque bolts that secure beams to platforms to 340-430 in-lb.

o. Remove hoist (stage).

Nomenclature	Part Number	Number Required	Shelf Number	Deck Location
Platform	9027190	4	2 each side of cart	One between each two outboard engine positions
Beam	9027188	4	3	One between each two outboard engine positions
Bracket	9027182	4	3	Engine positions 2, 3 and 4
Bracket	9027182-11	1	3	Engine position 3
Bracket	9027182-21	3	3	Engine positions 1, 2, and 4
Strut	9027178	8	2	Two between each two outboard engine positions
Strut	9027178-11	8	2	Two between each two outboard engine positions

Figure 5-3. G4071 Parts Required to Install Track Support

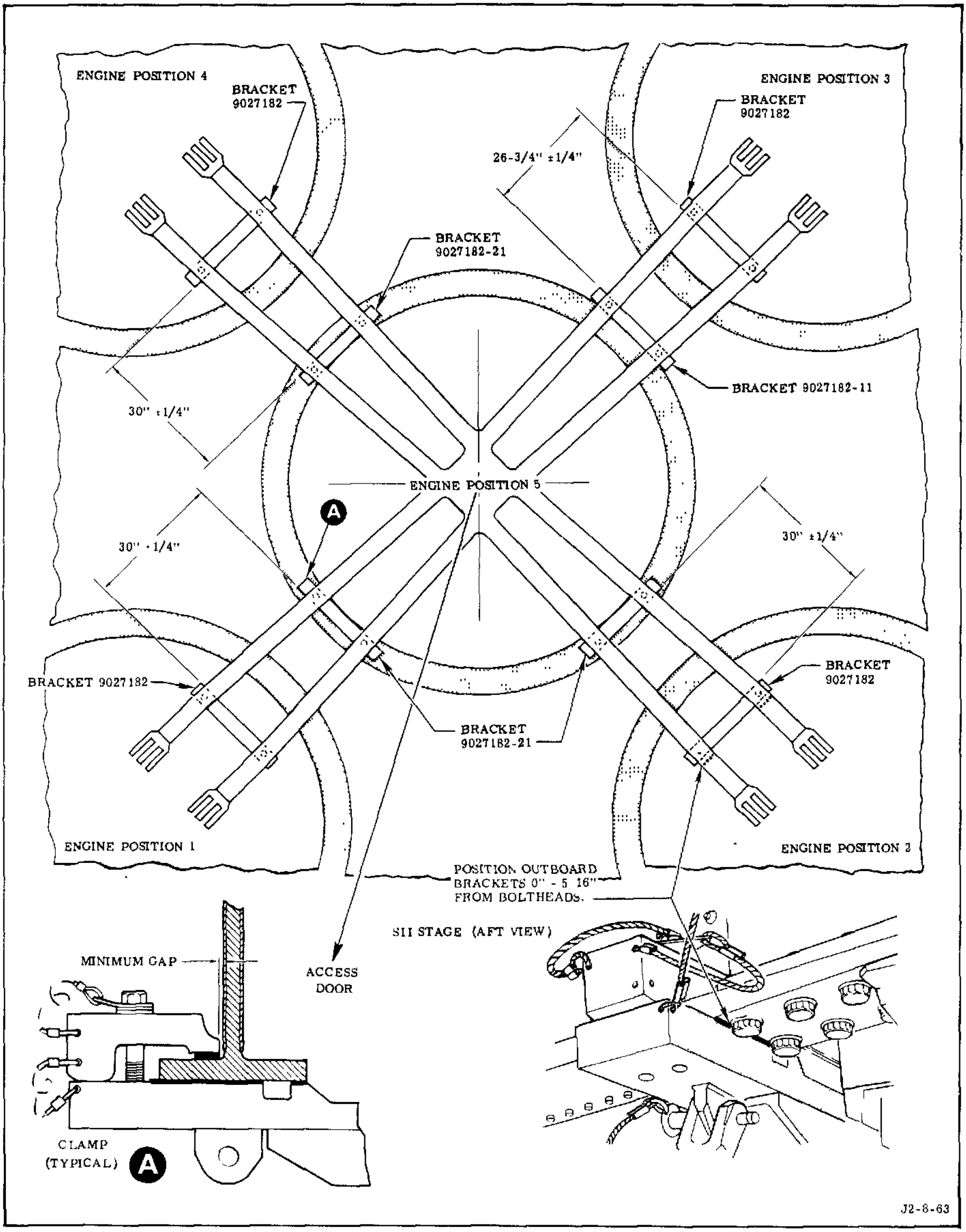


Figure 5-4. Location of Brackets 9027182

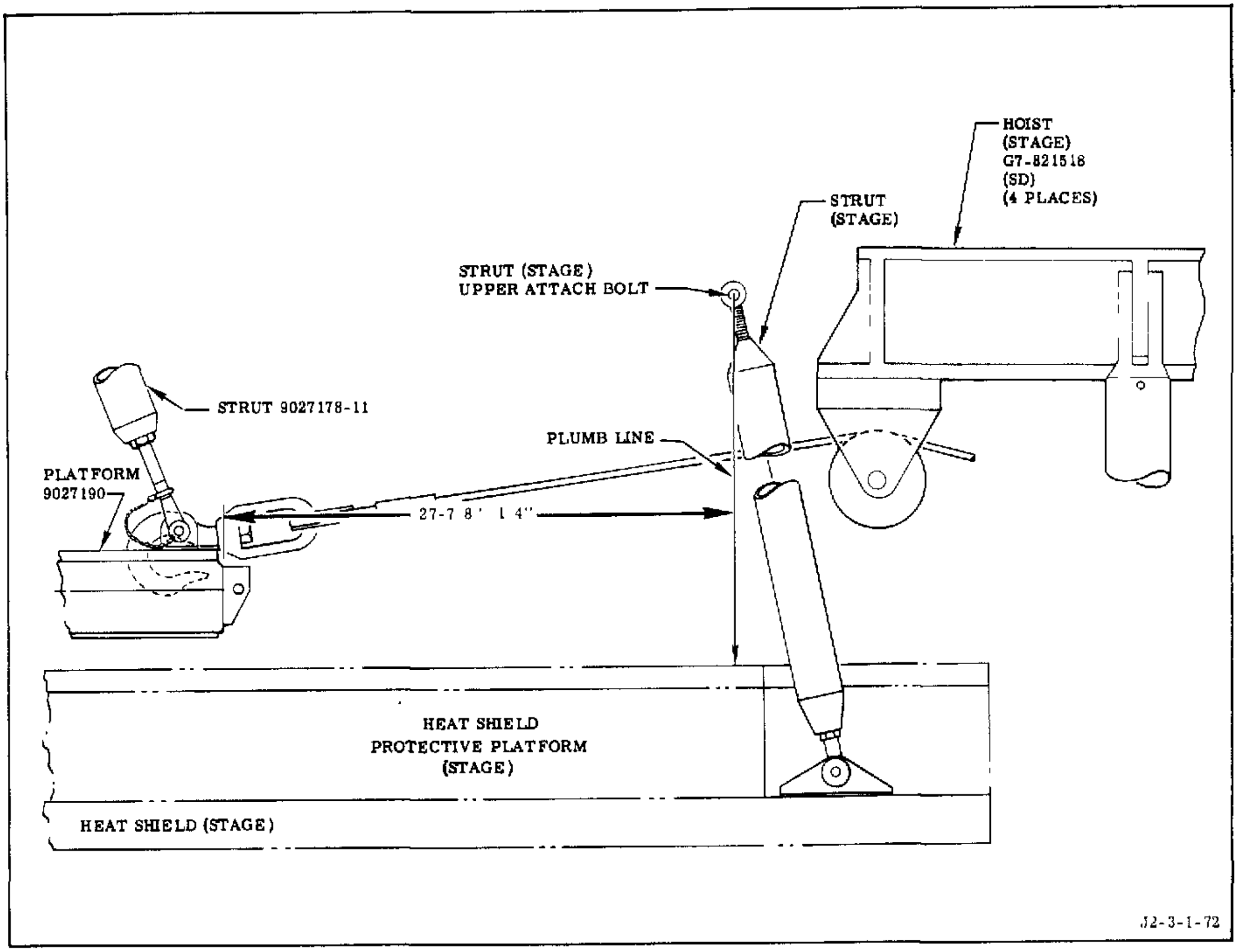


Figure 5-5. Positioning Platform

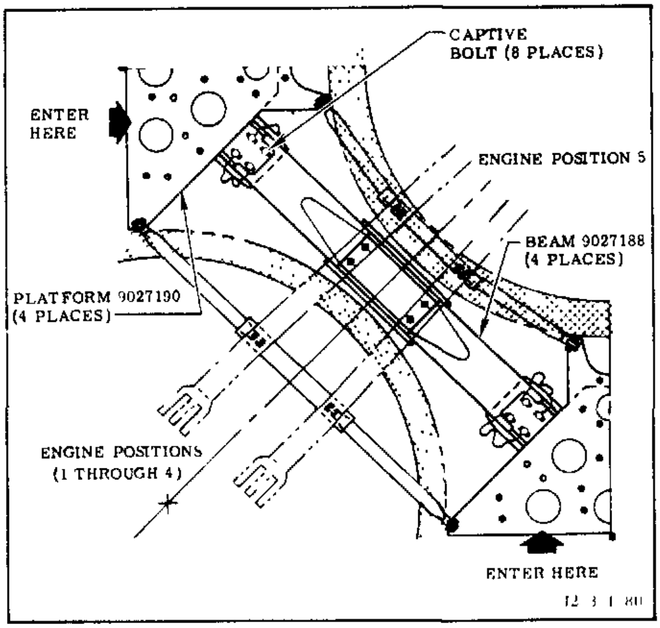


Figure 5-6. Beam Installed

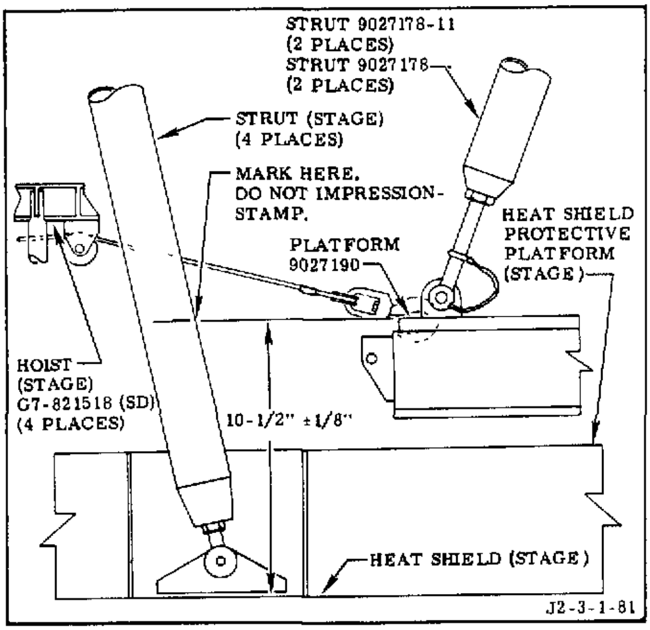


Figure 5-7. Platform Installed Height

5-9. REMOVING TRACK SUPPORT. Disassembly and removal requirements for the track support are obvious and require no special procedures. Heat shield limitations require that loads be limited to a maximum of 400 pounds per quadrant (including bridge sections) and lateral forces be kept to a minimum. Bumping or holding onto heat shield support struts is not permitted. Whenever possible, the loads must be applied to the track support structure rather than the heat shield. To calculate weight applied to heat shield, allow 96 pounds for each platform and 52 pounds for each beam. (See figure 5-6 for identifying platforms and beams.) Refer to section I for storage location of track support parts and install them in cart in reverse order of that listed in figure 5-3.

WARNING

Exceeding 400 pounds per quadrant, applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

5-10. <u>TRACK AND HOIST.</u>

5-11. The track and hoist are the direct means for supporting and transporting a component.

5-12. The G4071 and 9026251 provide five individual track configurations for the SII stage, one for each engine. Track configurations are similar in that they each provide a continuous track that virtually surrounds the affected engine and is supported by the stage work platform and the track support (paragraph 5-6). Heat shield limitations require that loads be limited to a maximum of 400 pounds per quadrant (including bridge sections) and lateral forces be kept to a minimum. Bumping or holding onto heat shield support struts is not permitted. Whenever possible, the loads must be applied to the track support structure rather than the heat shield. To aid in calculating weight applied to heat shield, the procedures give weights of parts exceeding 50 pounds.

WARNING

Exceeding 400 pounds per quadrant, applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

5-13. The G4072 provides six track configurations for the SIVB stage. The track configurations are determined by component removal and installation requirements.

5-14. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 1). When installed, the track appears as shown in figure 5-8.

a. Install track support (paragraph 5-8).

b. Obtain a spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent.

c. Obtain Engine Components Installer G4071 parts listed in figure 5-9. (Refer to paragraph 5-4 for information on unloading stowage cart.)

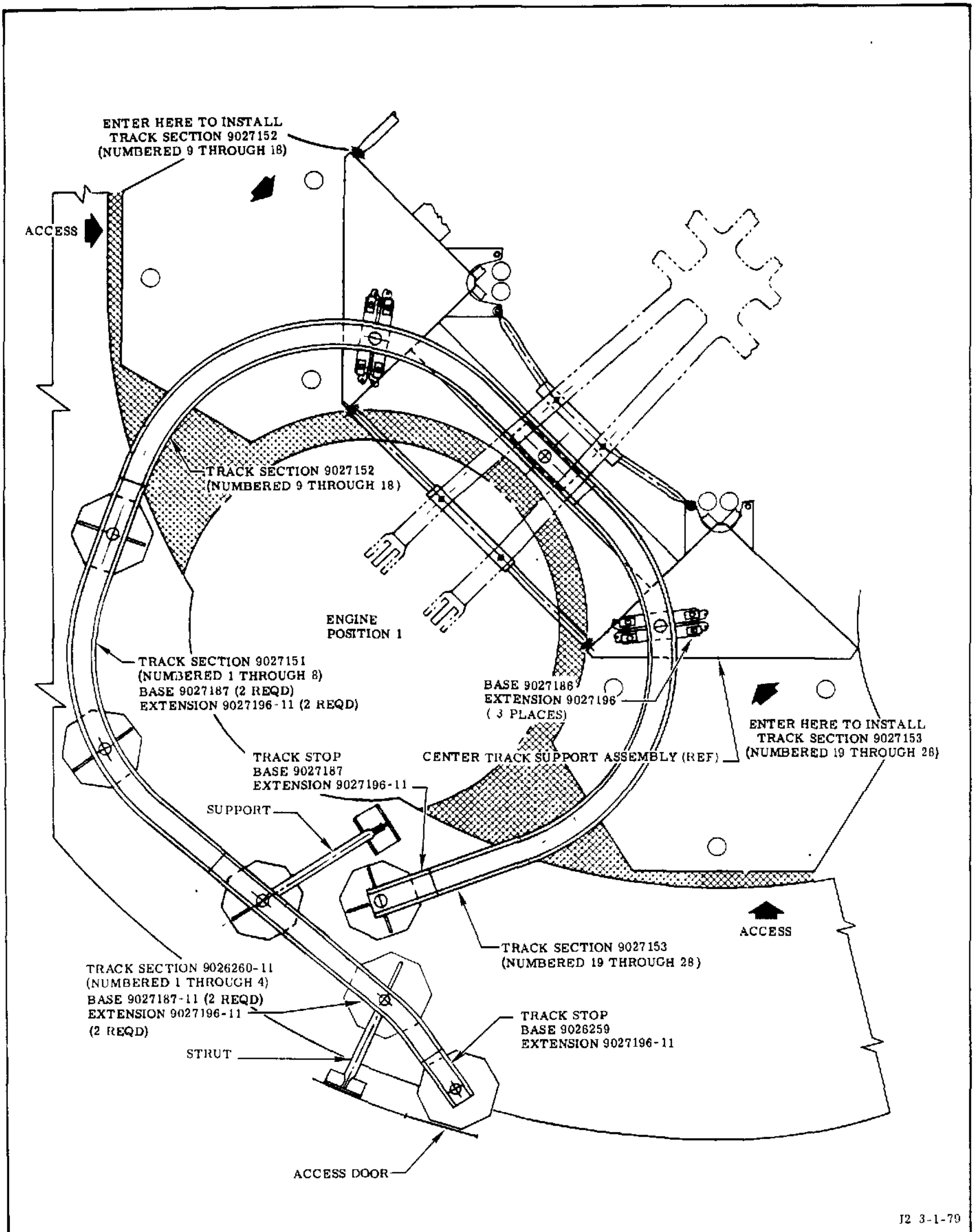


Figure 5-8. Location of Track Components for Engine Position 1

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)
Track section	9027151		5
Track section	9027152		5
Track section	9027153		5
Track stop	9027156	2	5
Track section	9026260-11		(a)
Support	9027200		4
Track pin	9027160	5	3
Support pin	9027161	9	3
Base	9027186	3	2
Base	9027187	3	2
Base	9027187-11	2	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196	3	1
Extension	9027196-11	6	1
Base	9026259		(a)
Strut	9026270		(a)

(a) Part of components installer set 9026251

Figure 5-9. Parts Required to Install Track for Engine Position 1

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base in center of beam between engine positions 1 and 5. (See figure 5-10.) Install captive bolts but do not tighten.

e. Place a base on platforms adjacent to engine position 1 in locations shown in figure 5-10. Do not install captive bolts at this time; however, thread one captive bolt fingertight into an available hole in platform so that cable acts as a lanyard to prevent base from falling.

f. Adjust nuts of extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

g. Insert an extension 9027196 into each base on platforms and beam.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

h. Install track section 9027152 (numbered 9 through 18) in location shown in figure 5-8 as follows: (Track section 9027152 weighs 94 pounds.)

(1) Position track section over extensions on beam and platform; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 5-11 for typical installation.)

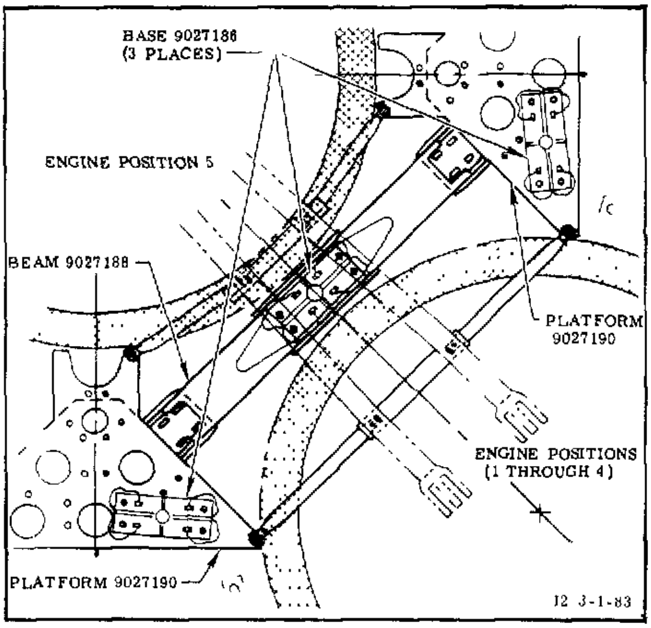


Figure 5-10. Location of Bases 9027186

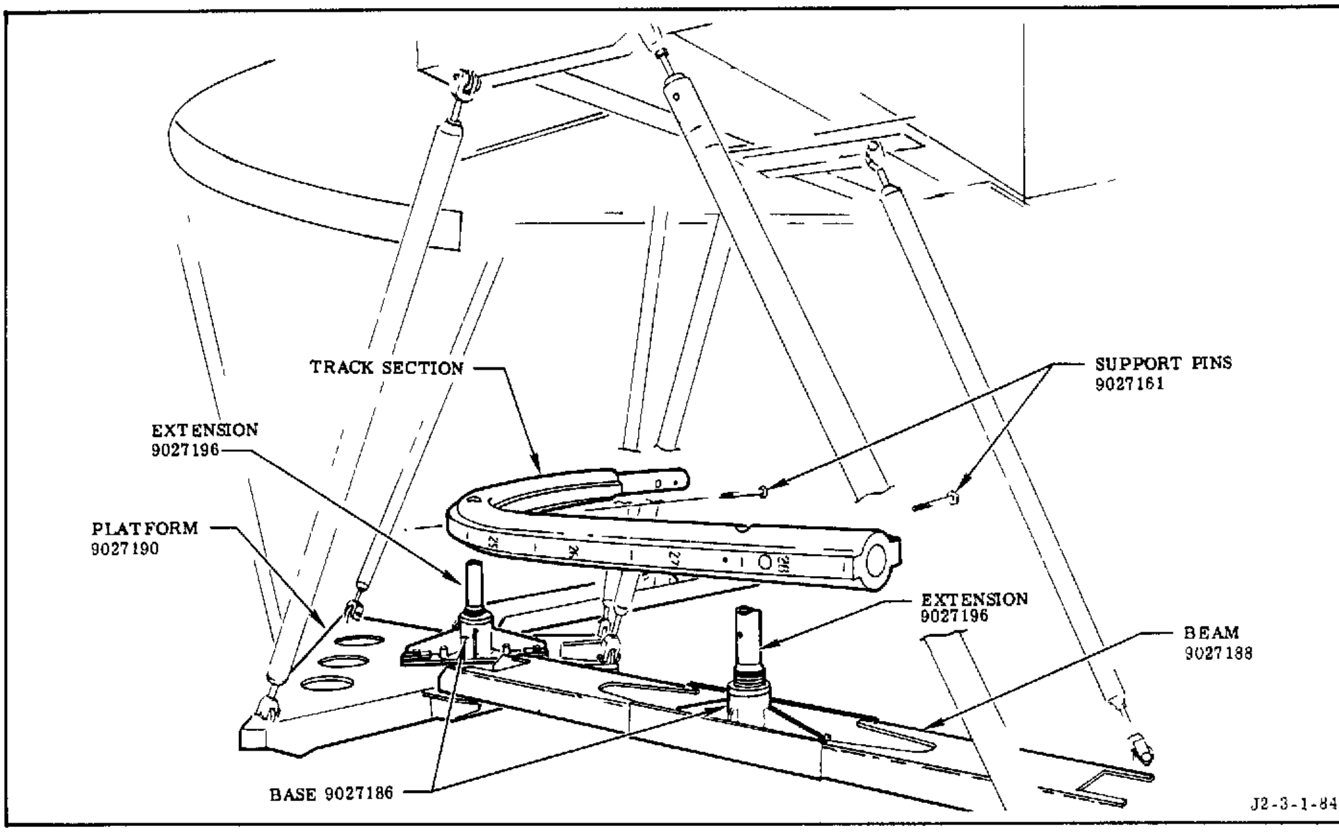


Figure 5-11. Positioning Track Section

(2) Secure track section to extensions with support pins. (See figure 5-11.) Tighten pins sufficiently to seat.

(3) Aline base on platform over proper bolt pattern (see figure 5-10) and install but do not tighten captive bolts.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track sections must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

i. Install track section 9027153 (numbered 19 through 28) in location shown in figure 5-8 as follows: (Track section 9027153 weighs 86 pounds.)

(1) Position track section over extension on platform; lower track section onto extension, moving base and extension to aline with track. (See figure 5-11 for typical installation.)

(2) Secure track section to extension with support pin. Tighten pin sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with a track pin. (See figure 5-13) for typical installation.)

(5) Aline base on platform over proper bolt pattern (see figure 5-10) and install but do not tighten captive bolts.

(6) Place a base 9027187 with an extension 9027196-11 approximately 2 feet from end of track section 9027153 (numbered 19 through 28).

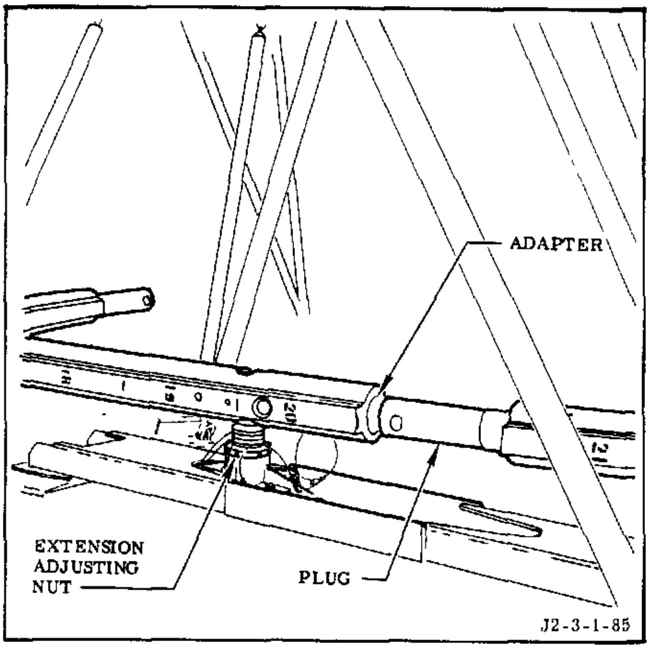


Figure 5-12. Alining Track Section

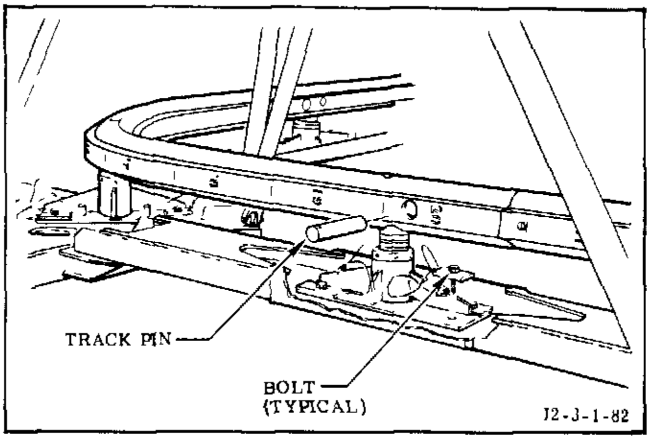


Figure 5-13. Securing Track Section

(7) Position stop (boltheads down) on extension and secure with support pin. Tighten pin sufficiently to seat.

(8) Adjust height of extension to aline track section 9027153; then push stop onto track section and secure with a track pin.

(9) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

j. Install track section 9027151 (numbered 1 through 8) in location shown in figure 5-8 as follows:

(1) Place 2 bases 9027187 on stage work deck in locations shown in figure 5-8 and insert an extension 9027196-11 into each base.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(5) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

k. Install track section 9026260-11 (numbered 1 through 4) in location shown in figure 5-8 as follows:

(1) Place 2 bases 9027187-11 on stage work deck in approximate locations shown in figure 5-8. Orient base lugs as shown.

(2) Place base 9026259 on stage access door step as shown in figure 5-8.

(3) Insert remaining extensions 9027196-11 into bases.

(4) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(5) Adjust height of extensions to aline track section with installed track. (See figure 5-12 for typical installation.)

(6) Join tracks and secure with a track pin. (See figure 5-13 for typical installation.)

(7) Verify that vertical adjustments of extensions supporting track are within 1/8 inch of each other.

l. Install support (figure 5-14) on base as shown in figure 5-8.

m. Install strut (figure 5-15) on base in location shown in figure 5-8.

n. Torque bolts that secure bases to platforms and beam to 340-430 in-lb.

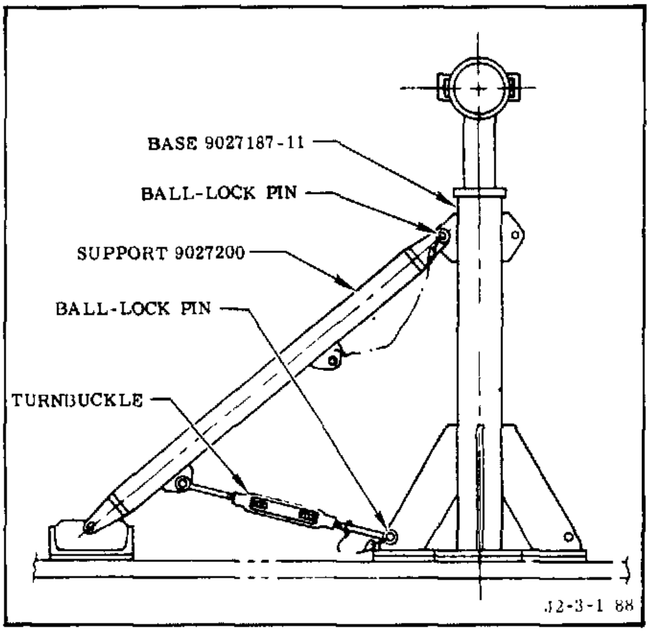


Figure 5-14. Support Installed

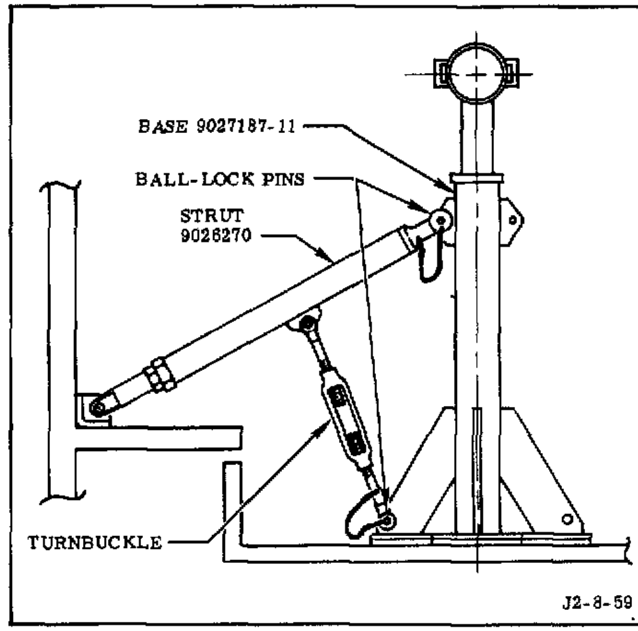


Figure 5-15. Strut Installed

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

o. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining track elevation to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027153 (numbered 19 through 28) to intersect matching surface on track section 9026260-11 (numbered 1 through 4).

p. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

q. Install stop (boltheads down) on track section 9026260-11 (numbered 1 through 4) and secure with track pin.

r. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

Missing roll pins can allow strut to be extended beyond safe limits, causing injury to personnel and damage to equipment.

s. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through holes in rod ends.

5-15. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 2). When installed, the track appears as shown in figure 5-16.

a. Install track support (paragraph 5-8).

b. Obtain a spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent.

c. Obtain Engine Components Installer G4071 parts listed in figure 5-17. (Refer to paragraph 5-4 for information on unloading stowage cart.)

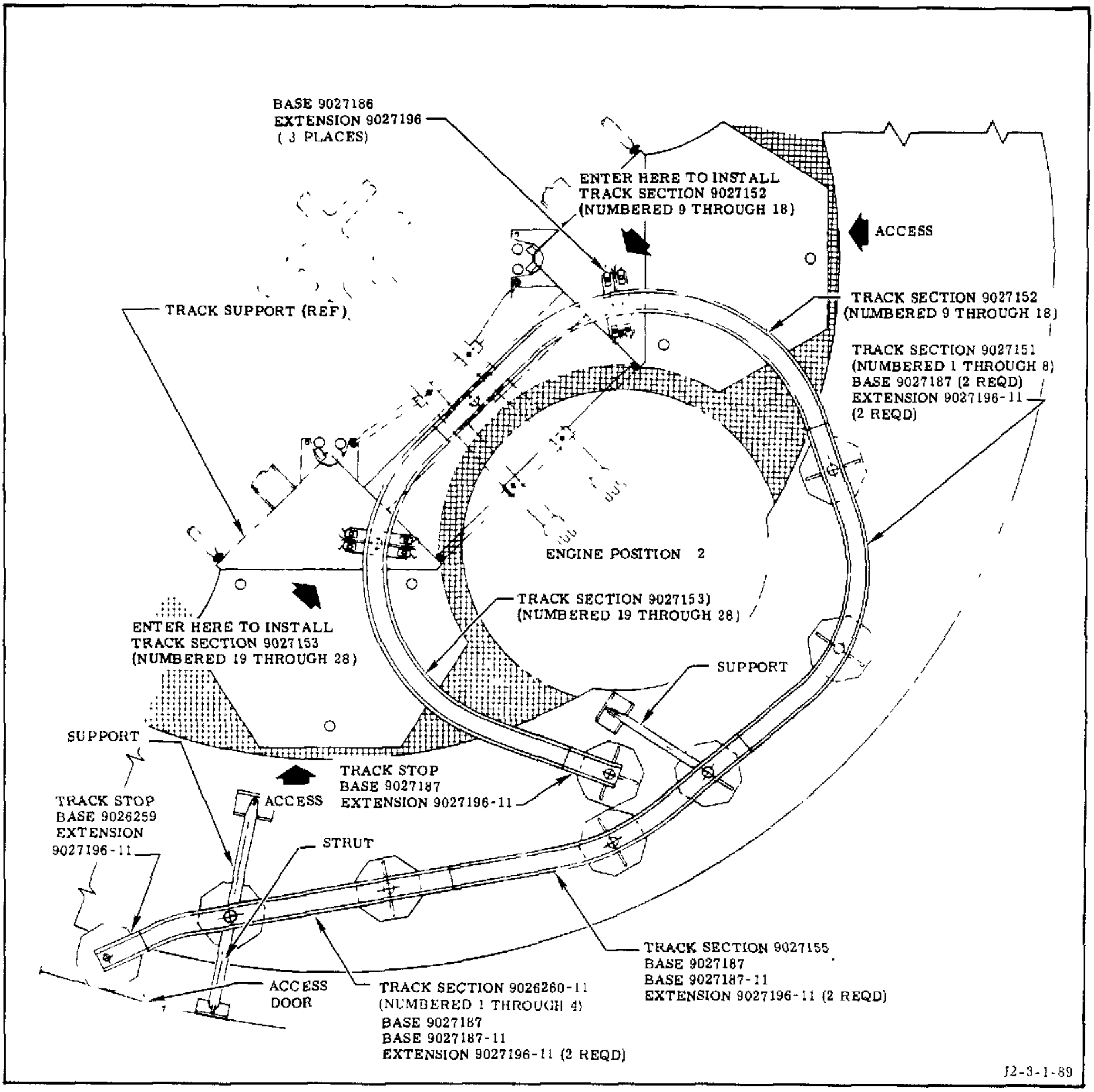


Figure 5-16. Location of Track Components for Engine Position 2

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)
Track section	9027151		5
Track section	9027152		5
Track section	9028153		5
Track stop	9027156	2	5
Track section	9026260-11		(a)
Track section	9027155		4
Support	9027200	2	4
Track pin	9027160	6	3
Support pin	9027161	11	3
Base	9027186	3	2
Base	9027187	5	2
Base	9027187-11	2	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196	3	1
Extension	9027196-11	8	1
Strut	9026270		(a)
Base	9026259		(a)

(a) Part of components installer set 9026251

Figure 5-17. Parts Required to Install Track for Engine Position 2

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base in center of beam between engine positions 2 and 5. (See figure 5-10.) Install captive bolts but do not tighten.

e. Place a base on each platform adjacent to engine position 2 in location shown in figure 5-10. Do not install bolts at this time; however, thread one captive bolt fingertight into an available hole in platform so that cable acts as a lanyard to prevent base from falling.

f. Adjust nuts of extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

g. Insert an extension 9027196 into each base on platforms and beam.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

h. Install track section 9027152 (numbered 9 through 18) in location shown in figure 5-16, as follows: (Track section 9027152 weighs 94 pounds.):

(1) Position track section over extensions on beam and platform; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 5-11 for typical installation.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Aline base on platform over proper bolt pattern (see figure 5-10) and install captive bolts but do not tighten.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

i. Install track section 9027153 (numbered 19 through 28) in location shown in figure 5-16 as follows: (Track section 9027153 weighs 86 pounds.)

(1) Position track section over extension on platform; lower track section onto extension, moving base and extension to aline with track. (See figure 5-11 for typical installation.)

(2) Secure track section to extension with support pin. Tighten pin sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(5) Aline base on platform over proper bolt pattern (see figure 5-10) and install captive bolts but do not tighten.

(6) Place a base 9027187 with an extension 9027196-11 approximately 2 feet from end of track section 9027153.

(7) Position stop (boltheads down) on extension and secure with support pin. Tighten pin sufficiently to seat.

(8) Adjust height of extension to aline stop with track section 9027153; then push stop onto track section and secure with track pin.

(9) Verify that vertical adjustment of extension on which track section is mounted is within 1/8 inch of extension on beam.

j. Install track section 9027151 (numbered 1 through 8) in location shown in figure 5-16 as follows:

(1) Place 2 bases 9027187 on stage work deck in locations shown in figure 5-16 and insert an extension 9027196-11 into each base.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(5) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

k. Install track section 9027155 (not numbered) in location shown in figure 5-16 as follows:

(1) Place 2 bases with extensions on stage work deck in locations shown in figure 5-16. Orient base incorporating lugs as shown.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pins. (See figure 5-13 for typical installation.)

l. Install a support (figure 5-14) on base of track section 9027155 in location shown in figure 5-16.

m. Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

n. Install track section 9026260-11 (numbered 1 through 4) in location shown in figure 5-16 as follows:

(1) Place 2 bases 9027187 and 9027187-11 with extensions on stage work deck in approximate locations shown in figure 5-16. Orient base incorporating lugs as shown.

(2) Place base 9026259 with extension on stage access door step as shown.

(3) Secure track section to extension with support pins. Tighten pins sufficiently to seat.

(4) Adjust height of extensions to aline track section with installed track. (See figure 5-12 for typical installation.)

(5) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(6) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

o. Install remaining support (figure 5-14) on base in location shown in figure 5-16.

p. Install strut (figure 5-15) on base in location shown in figure 5-16.

q. Torque bolts that secure bases to platforms and beam to 340-430 in-lb.

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

r. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining track elevation to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027153 (numbered 19 through 28) to intersect matching surface on track section 9027155 (not numbered).

s. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

t. Install stop (boltheads down) on track section 9026260-11 (numbered 1 through 4) and secure with track pin.

u. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

Missing roll pins can allow the strut to be extended beyond safe limits, causing injury to personnel and damage to equipment.

v. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through hole in rod ends.

5-16. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 3.) When installed, the track will appear as shown in figure 5-18.

a. Install track support (paragraph 5-8).

b. Obtain a spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent.

c. Obtain Engine Components Installer G4071 parts listed in figure 5-19. (Refer to paragraph 5-4 for information on unloading stowage cart.)

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base in center of beam between engine positions 3 and 5. (See figure 5-10.) Install captive bolts but do not tighten.

e. Place a base on each platform adjacent to engine position 3 in location shown in figure 5-10. Do not install bolts at this time; however, thread one captive bolt fingertight into an available hole in platform so that cable acts as a lanyard to prevent base from falling.

f. Adjust nuts of extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads using Molykote G paste (Dow Corning Corp).

g. Insert an extension 9027196 into each base on platforms and beam.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

h. Install track section 9027152 (numbered 9 through 18) in location shown in figure 5-18 as follows: (Track section 9027152 weighs 94 pounds.)

(1) Position track section over extensions on beam and platform; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 5-11 for typical installation.)

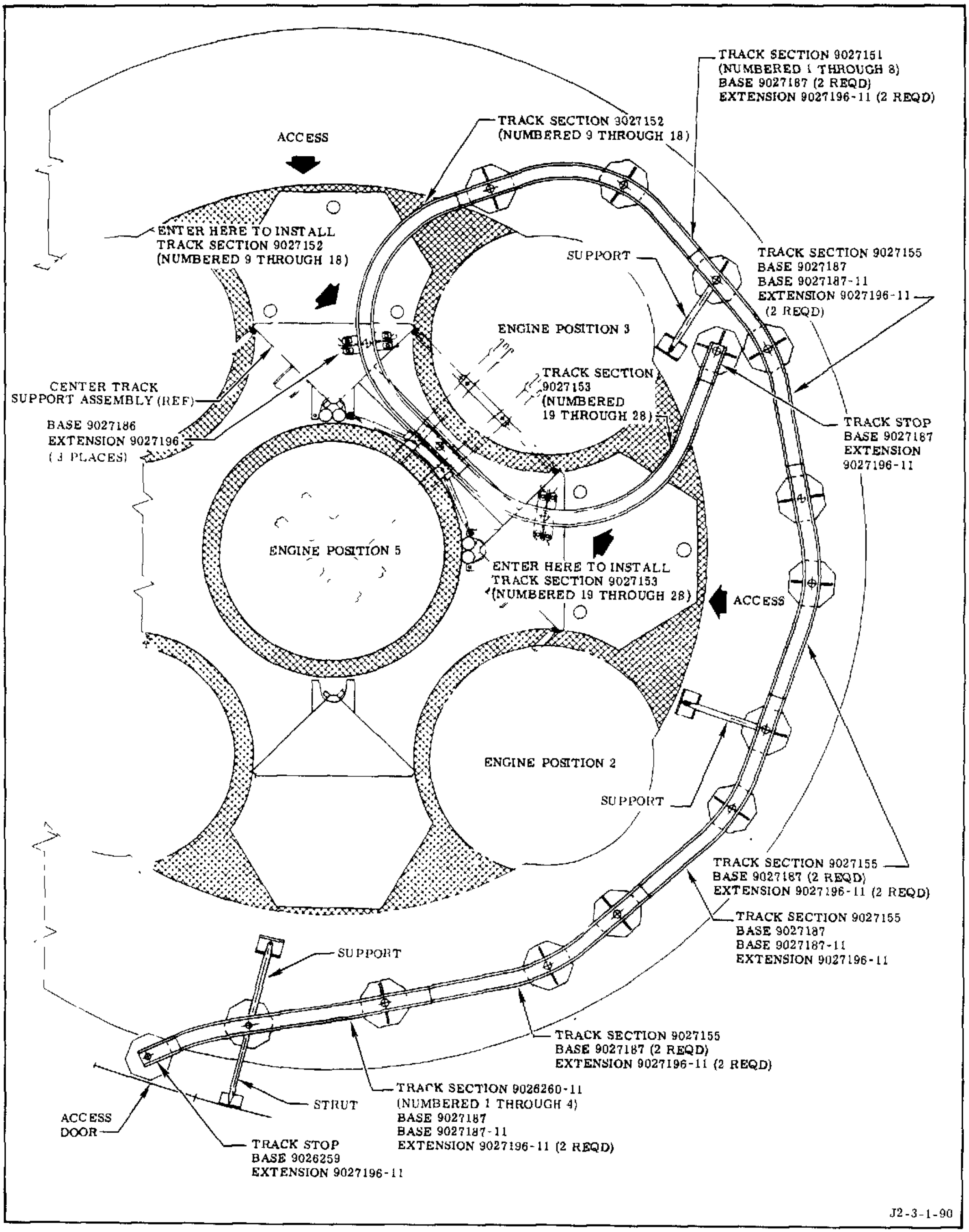


Figure 5-18. Location of Track Components for Engine Position 3

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)
Track section	9027151		5
Track section	9027152		5
Track section	9027153		5
Track stop	9027156	2	5
Track section	9026260-11		(a)
Track section	9027155	4	4
Support	9027200	3	4
Track pin	9027160	9	3
Support pin	9027161	17(b)	3
Base	9027186	3	2
Base	9027187	10	2
Base	9027187-11	3	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196	3	1
Extension	9027196-11	13	1
Strut	9026270		(a)
Base	9026259		(a)
Extension	9027196-11		(a)

(a) Part of components installer set 9026251
(b) G4071 has 16 only. (Procure one from spares, G4072, or 9026252.)

Figure 5-19. Parts Required to Install Track for Engine Position 3

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Aline base on platform over proper bolt pattern (see figure 5-12) and install captive bolts but do not tighten.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

i. Install track section 9027153 (numbered 19 through 28) in location shown in figure 5-18 as follows: (Track section 9027153 weighs 86 pounds.)

(1) Position track section over extension on platform; lower track section over extension, moving base and extension to aline with track. (See figure 5-11 for typical installation.)

(2) Secure track section to extension with support pin. Tighten pin sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(5) Aline base on platform over proper bolt pattern (see figure 5-10) and install captive bolts but do not tighten.

(6) Place a base 9027187 with an extension 9027196-11 approximately 2 feet from end of track section 9027153.

(7) Position stop (boltheads down) on extension and secure with support pin. Tighten pin sufficiently to seat.

(8) Adjust height of extension to aline stop with track section 9027153 (numbered 19 through 28); then push stop onto track section and secure with a track pin.

(9) Verify that vertical adjustment of extension on which track section is mounted is within 1/8 inch of extension located on beam.

j. Install track section 9027151 (numbered 1 through 8) in location shown in figure 5-18 as follows:

(1) Place 2 bases 9027187 with extensions on stage work deck in locations shown in figure 5-18.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track section. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(5) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

k. Install each of 4 track sections 9027155 (not numbered), consecutively, in locations shown in figure 5-18 as follows:

(1) Place 2 bases with extensions on stage work deck in locations shown in figure 5-18. Orient base incorporating lugs as shown.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track sections with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with a track pin. (See figure 5-13 for typical installation.)

l. Install a support (figure 5-14) on base of track section 9027155, in locations shown in figure 5-18.

m. Verify that vertical adjustments of extensions on which track sections are mounted are within 1/8 inch of each other.

n. Install track section 9026260-11 (numbered 1 through 4) in locations shown in figure 5-18 as follows:

(1) Place 2 bases 9027187 and 9027187-11 with extensions on stage work deck in locations shown in figure 5-18. Orient base incorporating lugs as shown.

(2) Place base 9026259 with extension on stage access door step as shown.

(3) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(4) Adjust height of extensions to aline track section with installed track. (See figure 5-12 for typical installation.)

(5) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(6) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

o. Install remaining support (figure 5-14) on base in location shown in figure 5-18.

p. Install strut (figure 5-15) on base in location shown in figure 5-18.

q. Torque bolts that secure bases to platforms and beams to 340-480 in-lb.

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

r. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining track elevation to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027153 (numbered 19 through 28) to intersect matching surface on adjacent track section 9027155 (not numbered).

s. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

t. Install stop (boltheads down) on track section 9026260-11 (numbered 1 through 4) and secure with track pin.

u. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

Missing roll pins can allow strut to be extended beyond safe limits, causing injury to personnel and damage to equipment.

v. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through holes in rod ends.

5-17. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 4). When installed, the track appears as shown in figure 5-20.

a. Install track support (paragraph 5-8).

b. Obtain a spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent.

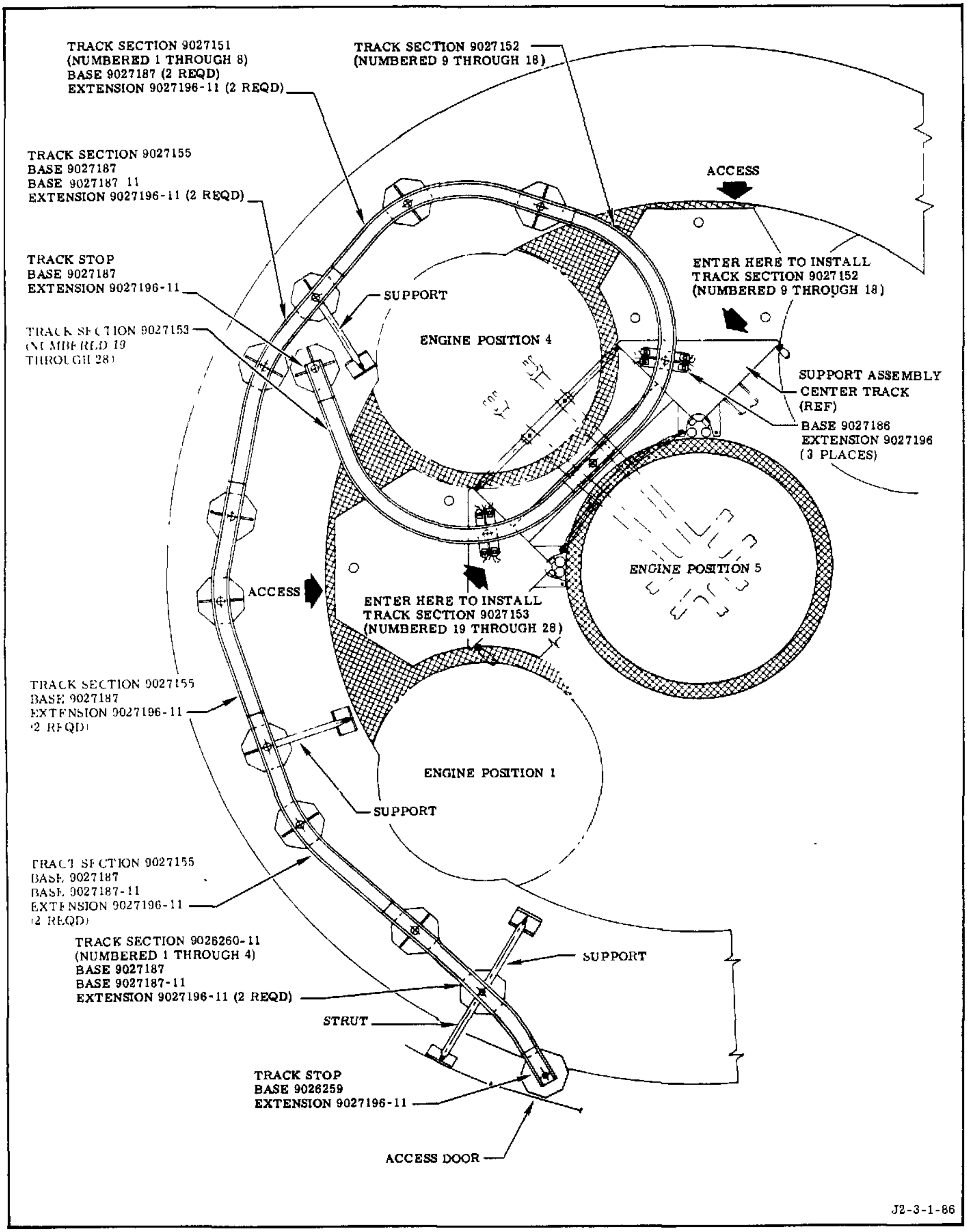


Figure 5-20. Location of Track Components for Engine Position 4

c. Obtain Engine Components Installer G4071 parts listed in figure 5-21. (Refer to paragraph 5-4 for information on unloading stowage cart.)

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base in center of beam between engine positions 4 and 5. (See figure 5-10.) Install captive bolts but do not tighten.

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)
Track section	9027151		5
Track section	9027152		5
Track section	9027153		5
Track stop	9027156	2	5
Track section	9026260-11		(a)
Track section	9027155	3	4
Support	9027200	3	4
Track pin	9027160	8	3
Support pin	9027161	15	3
Base	9027186	3	2
Base	9027187	8	2
Base	9027187-11	3	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196	3	1
Extension	9027196-11	12	1
Strut	9026270		(a)
Base	9026259		(a)

(a) Part of components installer set 9026251

Figure 5-21. Parts Required to Install Track for Engine Position 4

e. Place a base on each platform adjacent to engine position 4 in location shown in figure 5-10. Do not install bolts at this time; however, thread one captive bolt fingertight into an available hole in platform so that cable acts as a lanyard to prevent base from falling.

f. Adjust nuts of extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads, using Molykoke G paste (Dow Corning Corp).

g. Insert an extension 9027196 into each base on platforms and beam.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

h. Install track section 9027152 (numbered 9 through 18) in location shown in figure 5-20 as follows: (Track section 9027152 weighs 94 pounds.)

(1) Position track section over extensions on beam and platform; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 5-11 for typical installation.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Aline base on platform over proper bolt pattern (see figure 5-10) and install captive bolts but do not tighten.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

i. Install track section 9027153 (numbered 19 through 28) in location shown in figure 5-20 as follows:

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

(1) Position track section over extension on platform; lower track section over extension, moving base and extension, as necessary, to aline with track. (See figure 5-11 for typical installation.)

(2) Secure track section to extension with support pin. Tighten pin sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(5) Aline base on platform over proper bolt pattern (see figure 5-20) and install captive bolts. Torque captive bolts to 340-430 in-lb.

(6) Place a base with extension approximately 2 feet from end of track section 9027153 (numbered 19 through 28).

(7) Position stop (boltheads down) on extension and secure with support pin. Tighten pin sufficiently to seat.

(8) Adjust height of extension to aline stop with track section 9027153 (numbered 19 through 28); then push stop onto track section and secure with track pin.

(9) Verify that vertical adjustment of extension on which track section is mounted is within 1/8 inch of extension located on beam.

j. Install track section 9027151 (numbered 1 through 8) in location shown in figure 5-20 as follows:

(1) Place 2 bases with extensions on stage work deck in locations shown in figure 5-20.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

(5) Verify that vertical adjustments of extensions on which track section is mounted is within 1/8 inch of each other.

k. Install each of 3 track sections 9027155 (not numbered) consecutively, in locations shown in figure 5-20 as follows:

(1) Place 2 bases with extension on stage work deck in positions as shown in figure 5-20. Orient base incorporating lugs as shown.

(2) Secure track sections to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track sections 9027155 with installed track. (See figure 5-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 5-13 for typical installation.)

l. Install a support (figure 5-13) on base of track section 9027155 in locations shown in figure 5-20.

m. Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

n. Install track section 9026260-11 (numbered 1 through 4) in location shown in figure 5-20, as follows:

(1) Place 2 bases 9027187 and 9027187-11 with extensions on stage work deck in approximate locations shown in figure 5-20. Orient base incorporating lugs as shown.

(2) Place base 9026259 with extension on stage access door step as shown.

(3) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(4) Adjust height of extensions to aline track section with installed track. (See figure 5-12 for typical installation.)

(5) Join tracks and secure with track pins. (See figure 5-13 for typical installation.)

(6) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

o. Install remaining support (figure 5-14) on base in location shown in figure 5-20.

p. Install strut (figure 5-15) on base in location shown in figure 5-20.

q. Torque bolts that secure bases to platforms and beams to 340-430 in-lb.

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

r. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining track elevation to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027153 (numbered 19 through 28) to intersect matching surface on adjacent track section 9027155 (not numbered).

s. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

t. Install stop (boltheads down) on track section 9026260-11 (numbered 1 through 4) and secure with track pin.

u. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

Missing roll pins can allow strut to be extended beyond safe limits, causing injury to personnel and damage to equipment.

v. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through holes in rod ends.

5-18. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 5). When installed, the track appears as shown in figure 5-22.

a. Install track support (paragraph 5-8).

b. Obtain a spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent.

c. Obtain Engine Components Installer G4071 parts listed in figure 5-23. (Refer to paragraph 5-4 for information on unloading stowage cart.)

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base on platforms located between engine positions 2 and 3, 3 and 4, and 1 and 4 in locations shown in figure 5-22. Do not install bolts at this time; however, thread one captive bolt for each base fingertight into an available hole in platform so that cable acts as a lanyard to prevent bases from falling.

e. Place 2 bases 9027186 on platform located between engine positions 1 and 2 as shown in figure 5-24. Do not install bolts at this time; however, thread one captive bolt for each base fingertight into an available hole in platform so that cable acts as a lanyard to prevent bases from falling.

f. Place a base 9027186 in center cutout of beam 9027188, located between engine positions 1 and 5, and aline boltholes. Install captive bolts but do not tighten.

g. Place a base 9027186 in center cutout of each remaining beam and slide bases to the left (viewed toward engine position 5) as far as possible. Do not install bolts at this time.

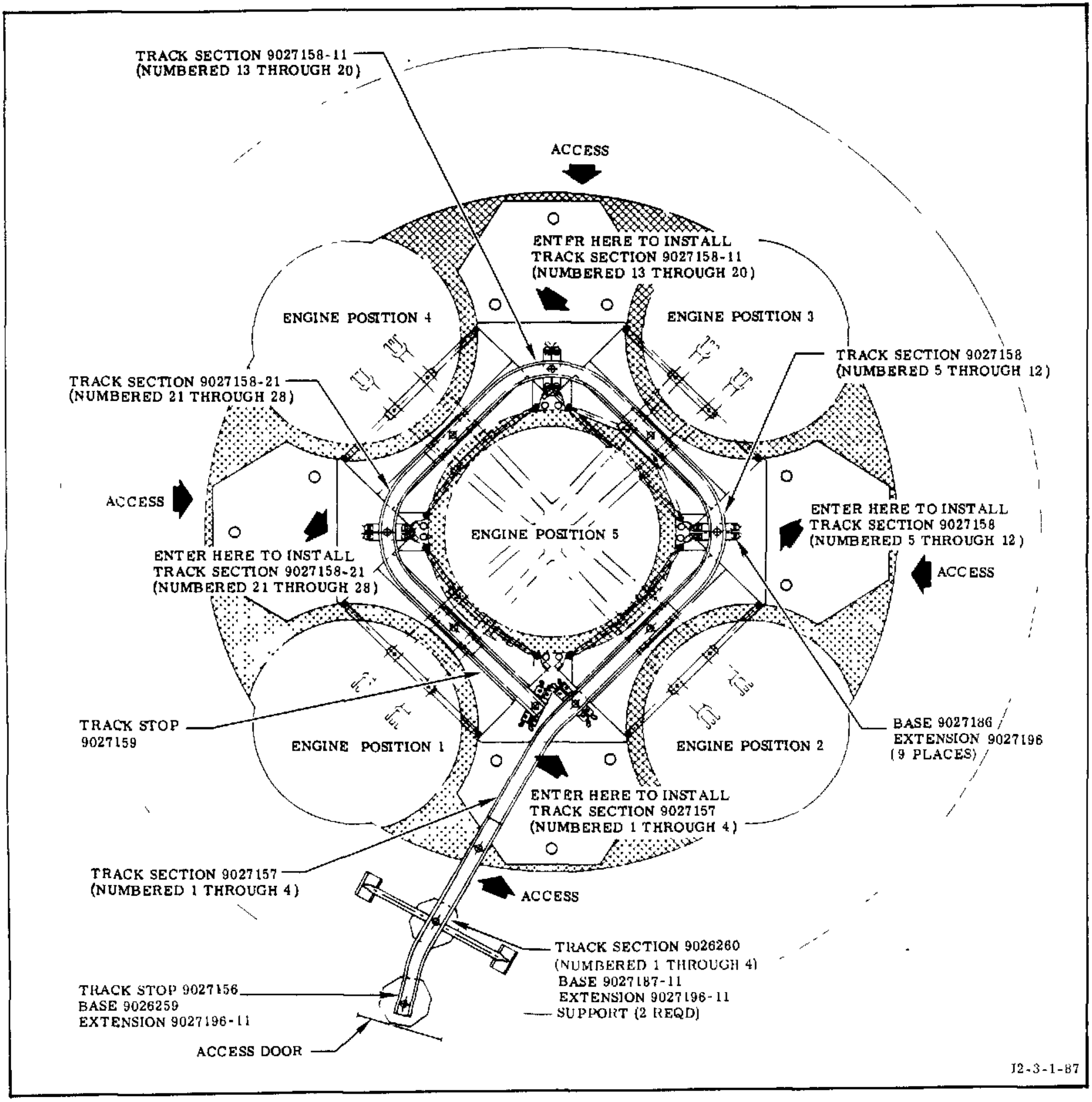


Figure 5-22. Location of Track Components for Engine Position 5

h. Rotate adjusting nuts of all extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

i. Insert an extension 9027196 into each previously placed base.

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)	Deck Location
Track section (numbered 5 through 12)	9027158		5	Between engine positions 2 and 3
Track section (numbered 13 through 20)	9027158-11		5	Between engine positions 3 and 4
Track section (numbered 21 through 28)	9027158-21		5	Between engine positions 1 and 4
Track stop	9027156		5	Between engine position 2 and stage access door
Track stop	9027159		5	Between engine position 4 and stage access door
Track section (numbered 1 through 4)	9027157		4	Between engine position 2 and stage access door
Track section	9026260		(a)	Between engine position 2 and stage access door
Support	9027200	2	4	Between engine position 1 and stage access door
Support pin	9027161	9	3	Between engine position 2 and stage access door
Track pin	9027160	6	3	Between engine position 2 and stage access door
Base	9027186	9	2	Two each with items 1, 2, 3, and 6; with item 5
Base	9027187-11		2	Between engine position 4 and stage access door
Turntable	9027101		2	Near access door
Boom	9027051		2	Near access door
Extension	9027196-11		2	Between engine position 4 and stage access door
Extension	9027196	9	1	Two each with items 1, 2, 3, and 6; 1 with item 5
Base	9026259		(a)	Between engine position 2 and stage access door.

(a) Part of components installer set 9026251

Figure 5-23. Parts Required to Install Track for Engine Position 5

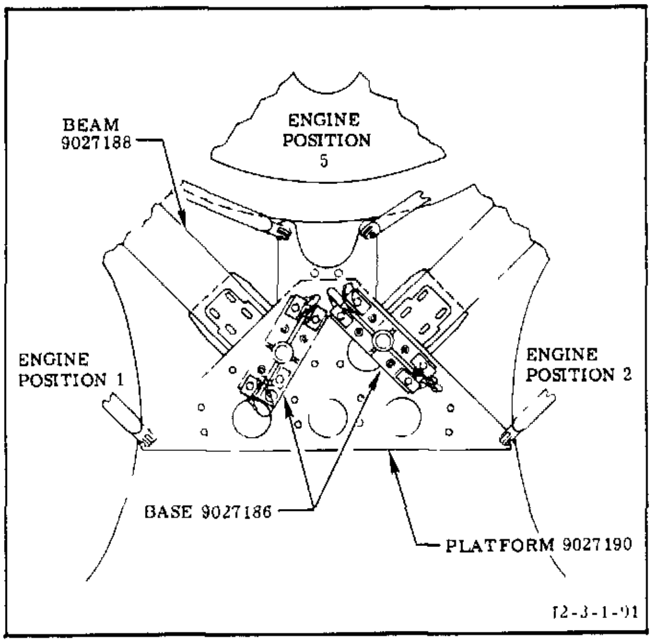


Figure 5-24. Location of Bases 9027186 for Engine Position 5

j. Install track section 9027158-21 (numbered 21 through 28) in location shown in figure 5-22 as follows:

(1) Position track section over extensions; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 5-11.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

NOTE

Base nearest engine position 1 will pick up 3 boltholes only.

(3) Aline base on platform over proper bolt pattern (see figure 5-24) and install captive bolts but do not tighten.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

k. Place stop 9027159 (boltheads down) on extension on platform in location shown in figure 5-22 and secure with a support pin. Tighten pin sifficiently to seat.

l. Adjust height of extension, as necessary, to aline stop with track. Join stop with track and secure with track pin.

m. Aline base on platform as shown in figure 5-22 and install captive bolts but do not tighten.

n. Verify that vertical adjustments of extensions supporting track section 9027158-21 and stop are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

o. Install track section 9027158-11 (numbered 13 through 20) in location shown in figure 5-22 as follows:

(1) Position track section over extensions; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 5-11.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 5-12.)

(4) Join tracks and secure with track pin. (See figure 5-13.)

(5) Aline base of platform and beam over proper bolt pattern (see figure 5-22) and install captive bolts but do not tighten.

(6) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

p. Install track section 9027158 (numbered 5 through 12) in location shown in figure 5-22 as follows:

(1) Position track section over extensions; lower track section onto extension, moving extension and base platform to aline with track. (See figure 5-11.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 5-12.)

(4) Join tracks and secure with track pin. (See figure 5-13.)

(5) Aline bases on platform and beam over proper bolt pattern (see figure 5-22) and install captive bolts.

(6) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

q. Install track section 9027157 (numbered 1 through 4) in location shown in figure 5-22 as follows:

(1) Position track section over extensions; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 5-11.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 5-12.)

(4) Join track sections and secure with a track pin. (See figure 5-13.)

(5) Aline bases on platform (figure 5-24) and beam over proper bolt pattern and install captive bolts but do not tighten.

(6) Verify that vertical adjustments of extension on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent injury to personnel and damage to equipment.

r. Install track section 9026260 (numbered 1 through 4) in location shown in figure 5-22 as follows:

(1) Place base 9027187-11 with extension on stage work deck near access door in location shown in figure 5-22.

(2) Place base 9026259 with extension on stage access door step as shown.

(3) Install track section on extension and secure with support pin. Tighten pin sufficiently to seat.

(4) Adjust extension to aline track section with installed track section.

(5) Join tracks and secure with track pin. Tighten pin sufficiently to seat.

(6) Install 2 supports 9027200 (figure 5-14) on base in location shown in figure 5-22.

s. Torque all bolts that secure bases to platforms and beams to 340-430 in-lb.

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

t. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining elevation of track to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027158-21 (numbered 21 through 28) to intersect matching surface on adjacent track section 9027157 (numbered 1 through 4).

u. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

v. Install stop (boltheads down) on track section 9026260 (numbered 1 through 4) and secure with a track pin.

w. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

> Missing roll pins can allow strut to be extended beyond safe limits, causing injury to personnel and damage to equipment.

x. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through holes in rod ends.

5-19. INSTALLING TRACK AND HOIST (SIVB STAGE). This paragraph contains illustrations of track configurations and a track assembly procedure. Each illustration title contains the names of the engine components handled by the illustrated track configuration and the vehicle stage series (200 or 500) to which the figure is applicable. The figure illustrates the assembled track and locates the parts for proper assembly. The procedure is applicable to all the illustrations and only requires the user to know the required direction (leading or trailing) of the hoist controls when installing the hoist.

NOTE

> In the following procedure, whenever reference is made to a figure and its number is not given, it is to be interpreted as the figure illustrating the track configuration required for the component to be removed.

a. Locate figure illustrating required track configuration for component to be removed. (See figure 5-25 through 5-36.) Select figure on basis of ultimate component to be removed. Do not select figure on basis of a need to remove an additional component to gain access. Track configurations allow for removal of components required for access. Make sure selected figure is for applicable vehicle.

b. If figure indicates need to install access work platform, assemble and install access work platform. (Refer to paragraph 5-34.)

c. Obtain Engine Components Installer G4072 parts for selected track configuration. (See figure 5-37.)

d. Obtain a spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent.

e. Place base plates in approximate location and orientation shown in figure.

f. Place a track base on each base plate.

g. Insert an extension into each track base.

h. Adjust length of each extension to 3-5/8 ±1/16 inches from center of 1/2-inch hole (at top of extension) to top of extension adjustment nut. If nut is difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

i. Secure a stop to extension located at starting point in the figure. Secure stop to extension with a support pin. Tighten support pin sufficiently to seat.

j. Starting at installed stop, install remainder of parts in succession, except remaining stop, as follows:

(1) Before mating each track section, make sure mating surfaces are clean and free of burs or damage that could impair mating. If mating surfaces are burred or damaged, refer to R-3825-5 for repair.

CAUTION

> Mating portions of track sections are a close tolerance fit. Dirt or damage may make proper assembly or disassembly difficult, potentially resulting in additional damage to these surfaces.

(2) Install each track section by first securing the section to its respective extension with a support pin, then mating it to previously installed part and securing with a track pin. Tighten support pins until seated, and install track pins so pins do not protrude beyond outer surfaces of track.

(3) Position track to meet dimensional requirements of figure during track assembly.

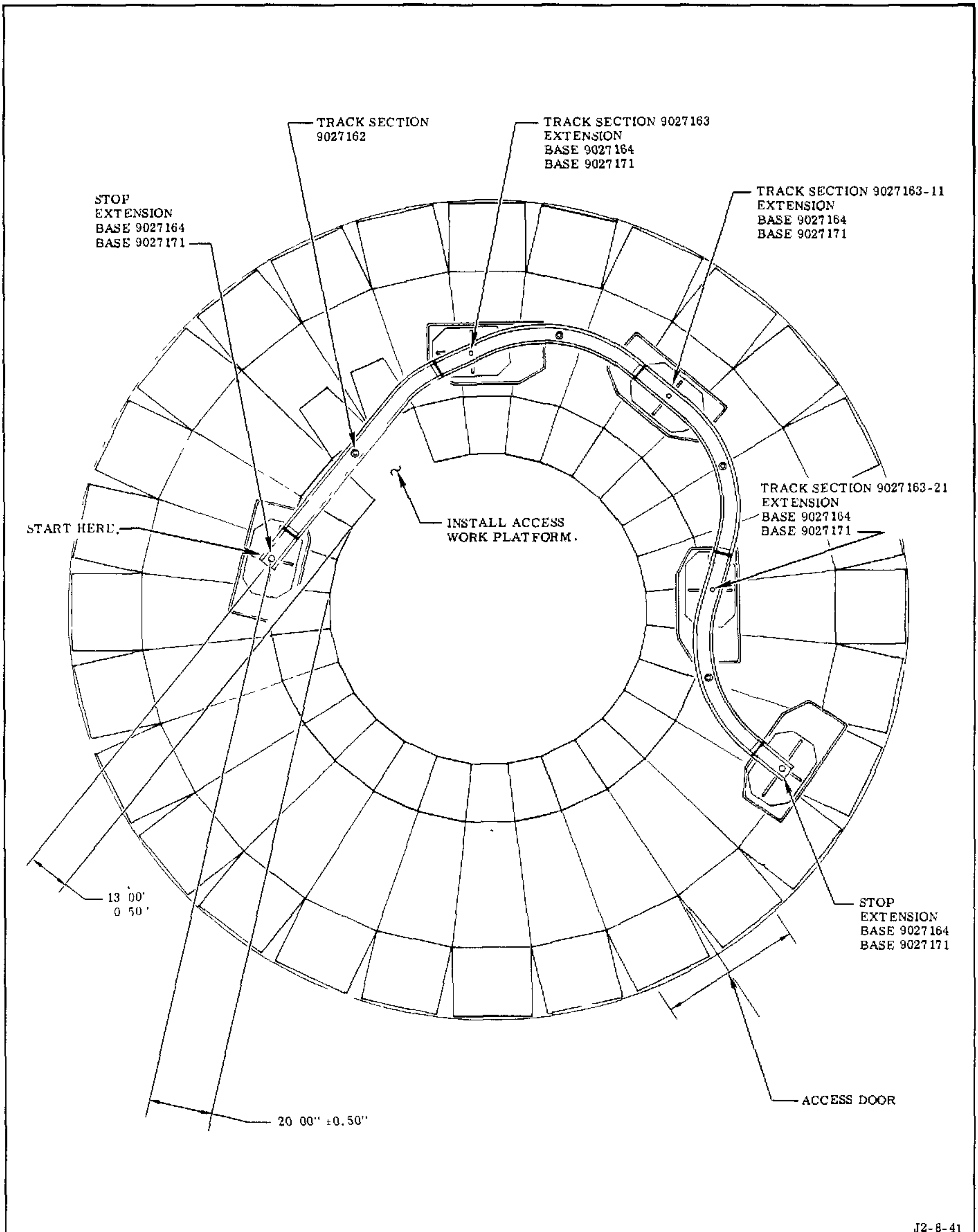


Figure 5-25. Location of Track Components for Removing Electrical Control Assembly and Fuel High-Pressure Duct (200-Series Stage)

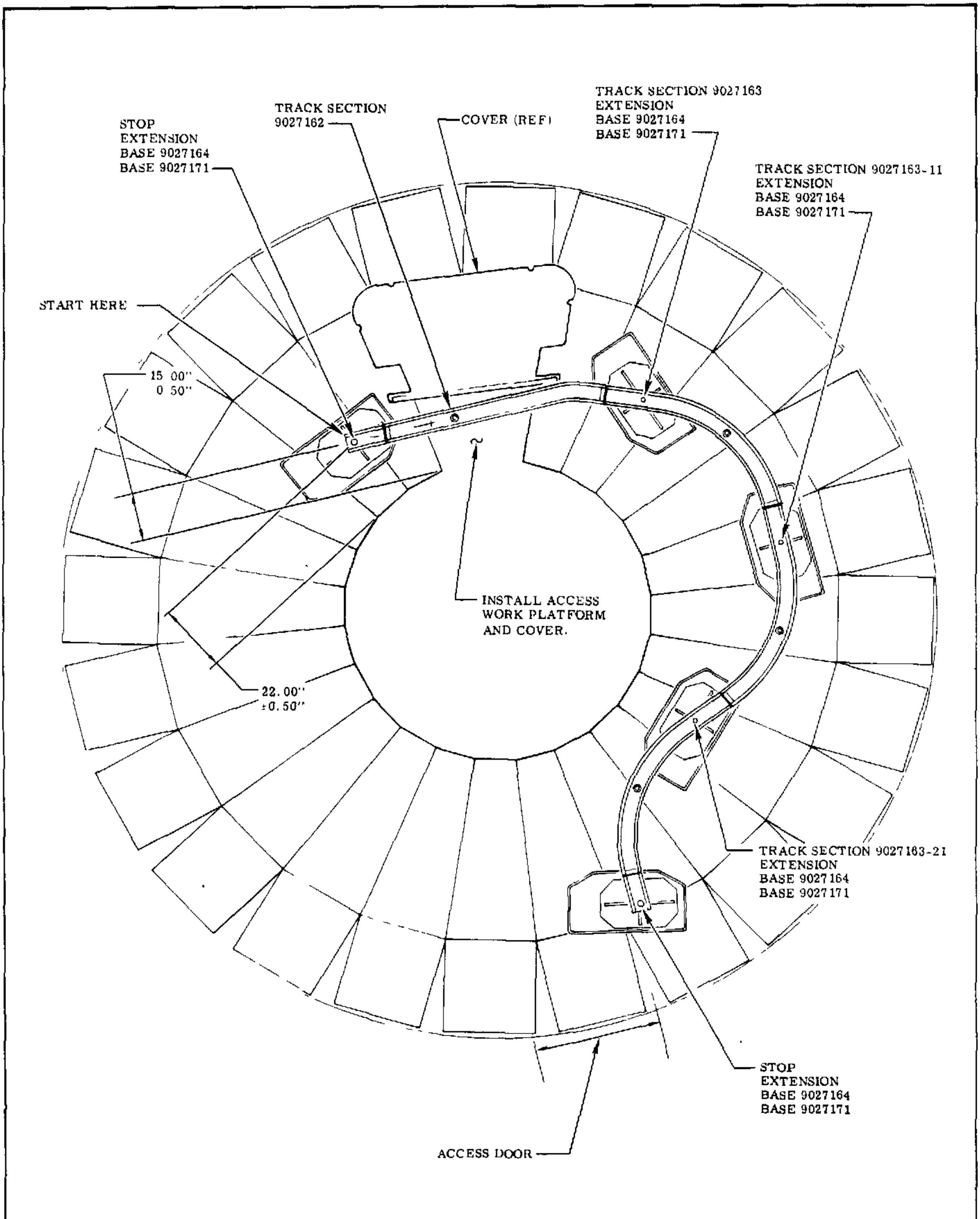


Figure 5-26. Location of Track Components for Removing Electrical Control Assembly and Fuel High-Pressure Duct (500-Series Stage)

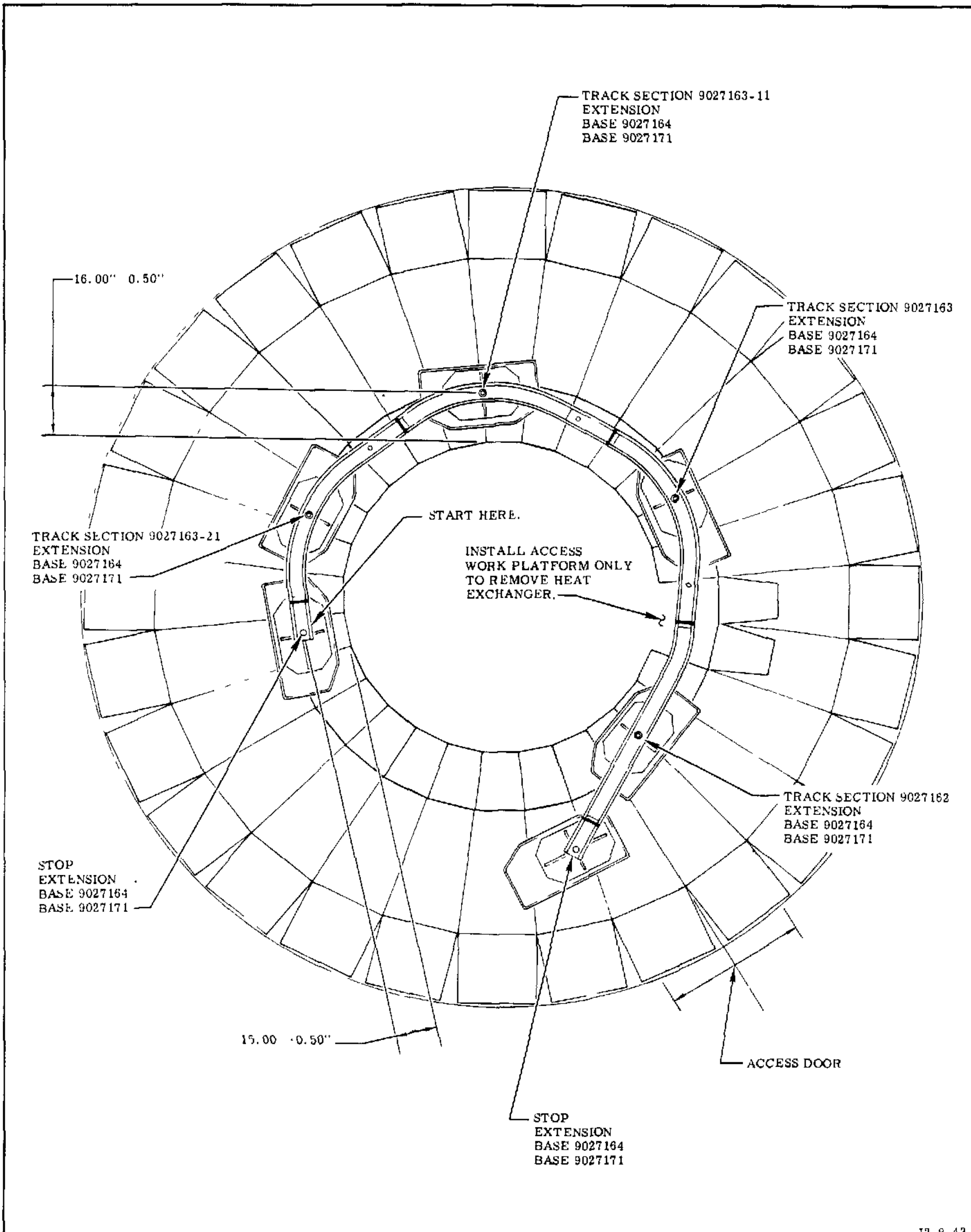


Figure 5-27. Location of Track Components for Removing Fuel Inlet Duct, Gimbal, Heat Exchanger, and Oxidizer Inlet Duct (200-Series Stage)

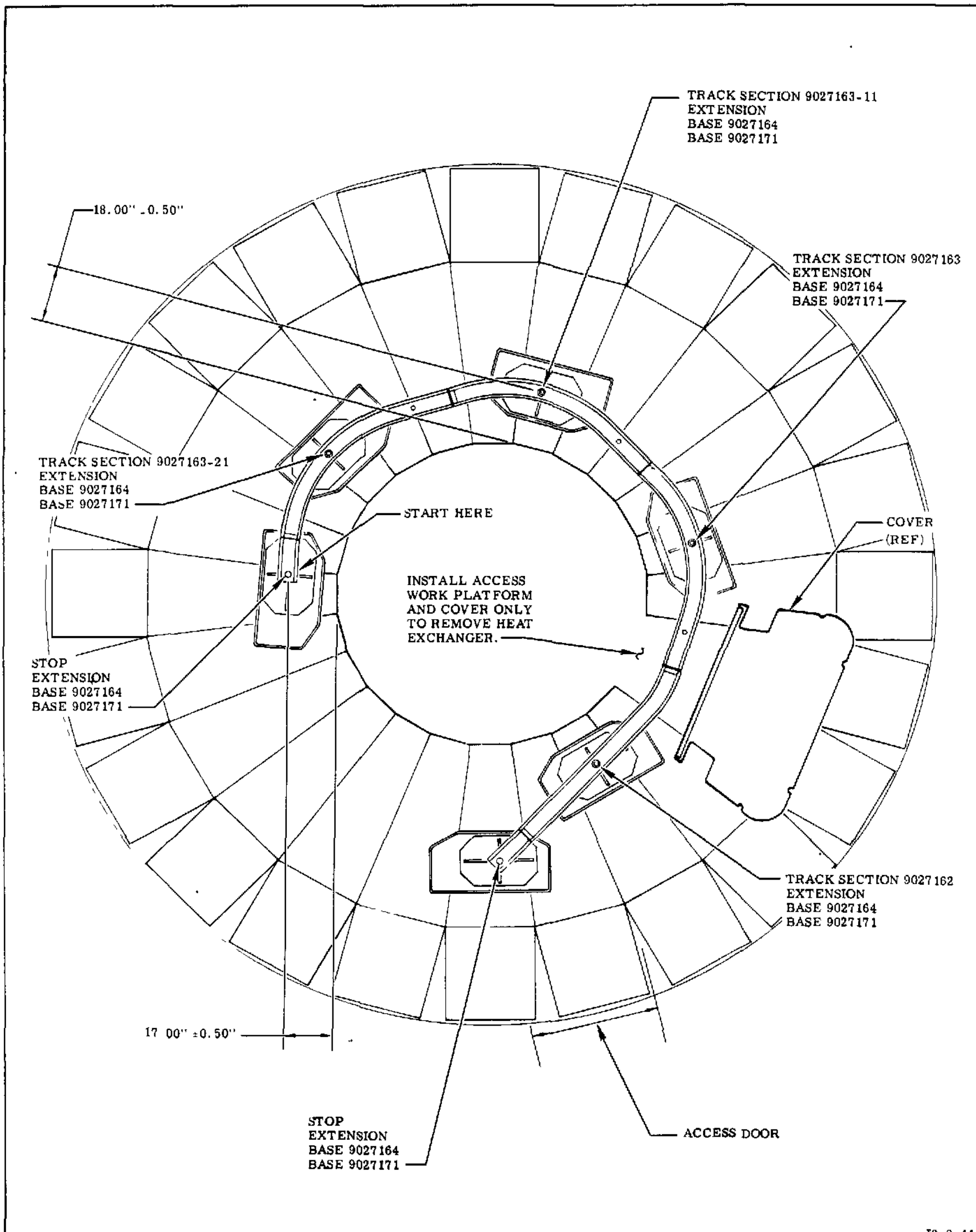


Figure 5-28. Location of Track Components for Removing Fuel Inlet Duct, Gimbal, Heat Exchanger, and Oxidizer Inlet Duct (500-Series Stage)

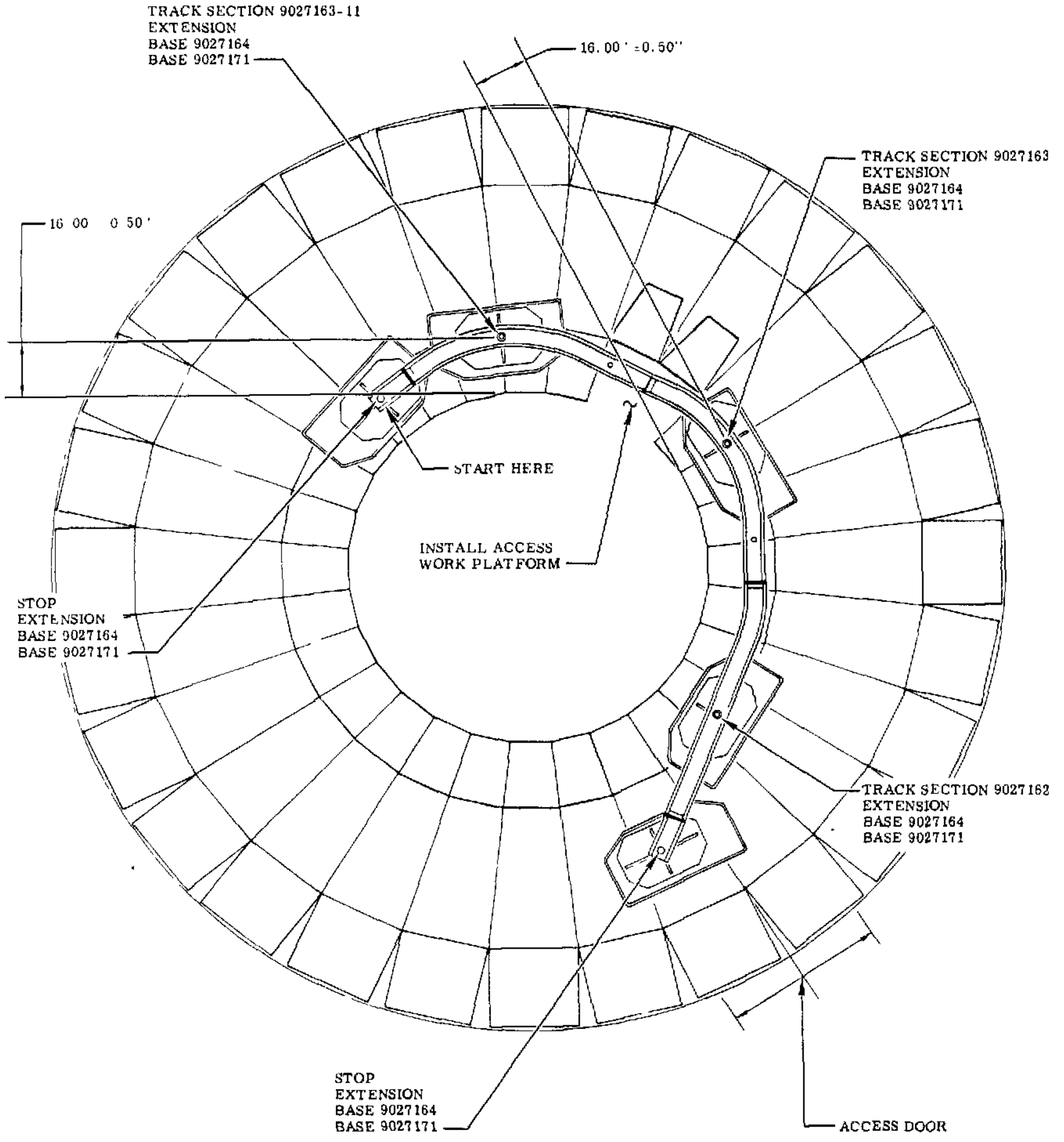


Figure 5-29. Location of Track Components for Removing Oxidizer High-Pressure Duct and Primary Flight Instrumentation Package (200-Series Stage)

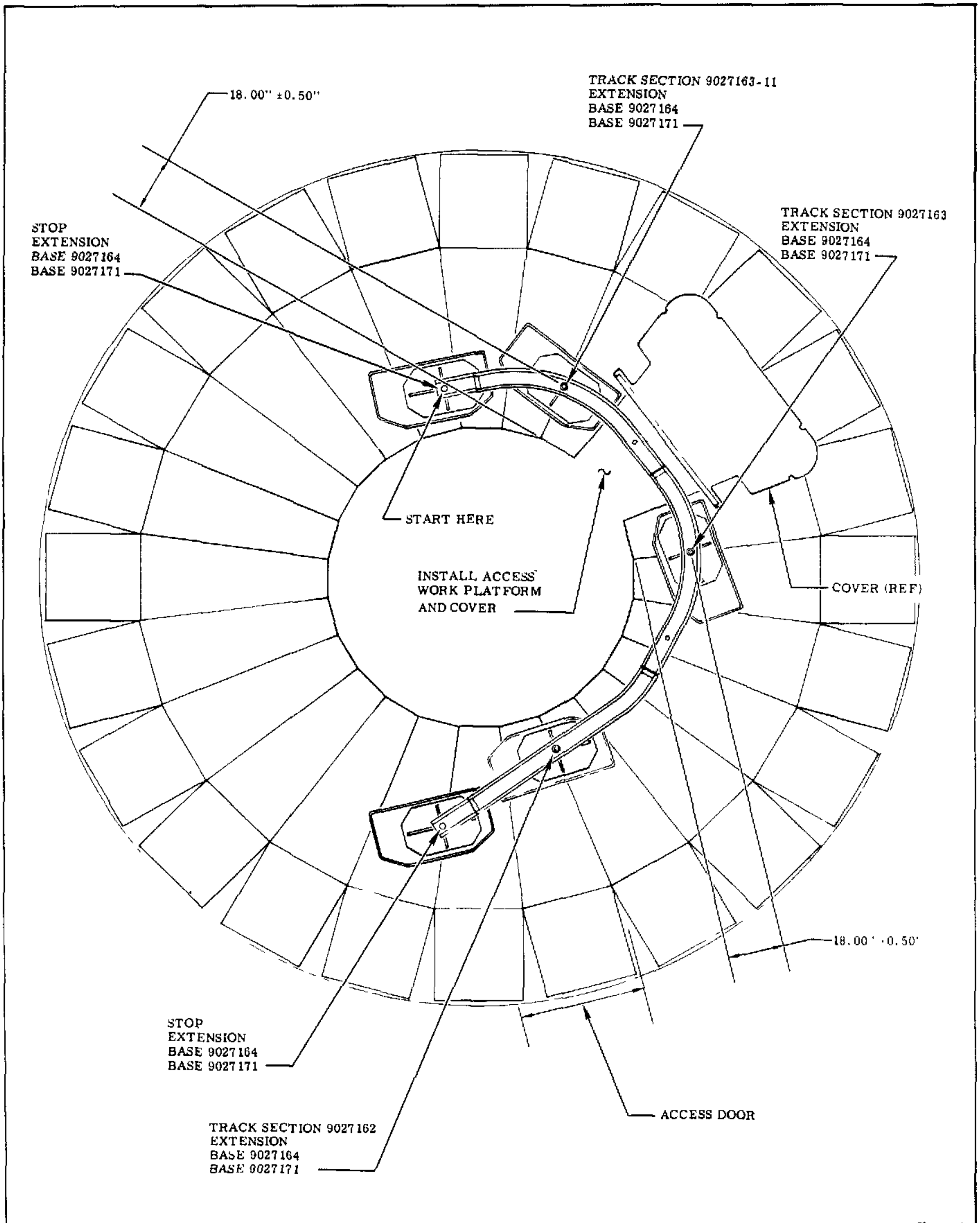


Figure 5-30. Location of Track Components for Removing Oxidizer High-Pressure Duct and Primary Flight Instrumentation Package (500-Series Stage)

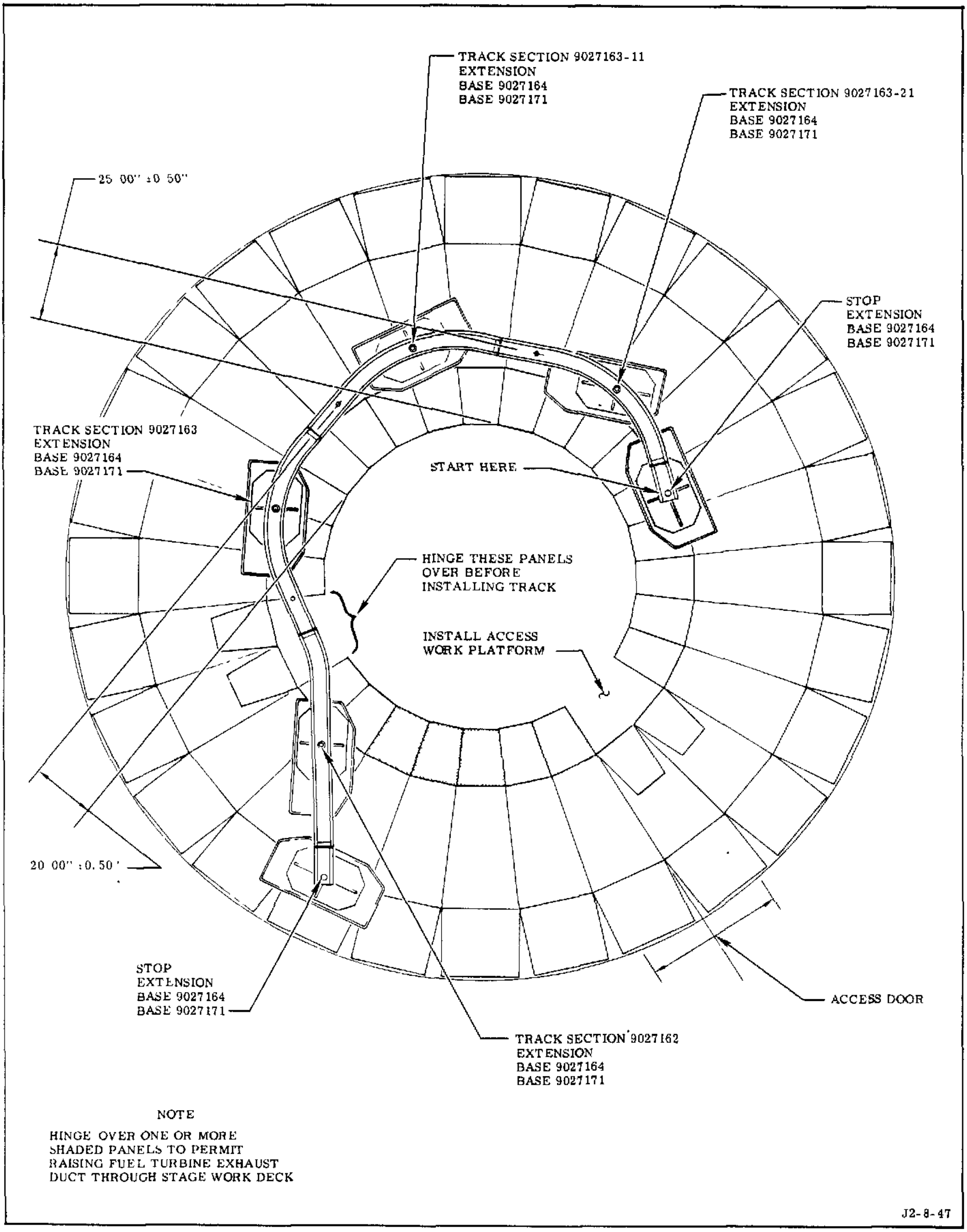


Figure 5-31. Location of Track Components for Removing Turbine Exhaust Duct (200-Series Stage)

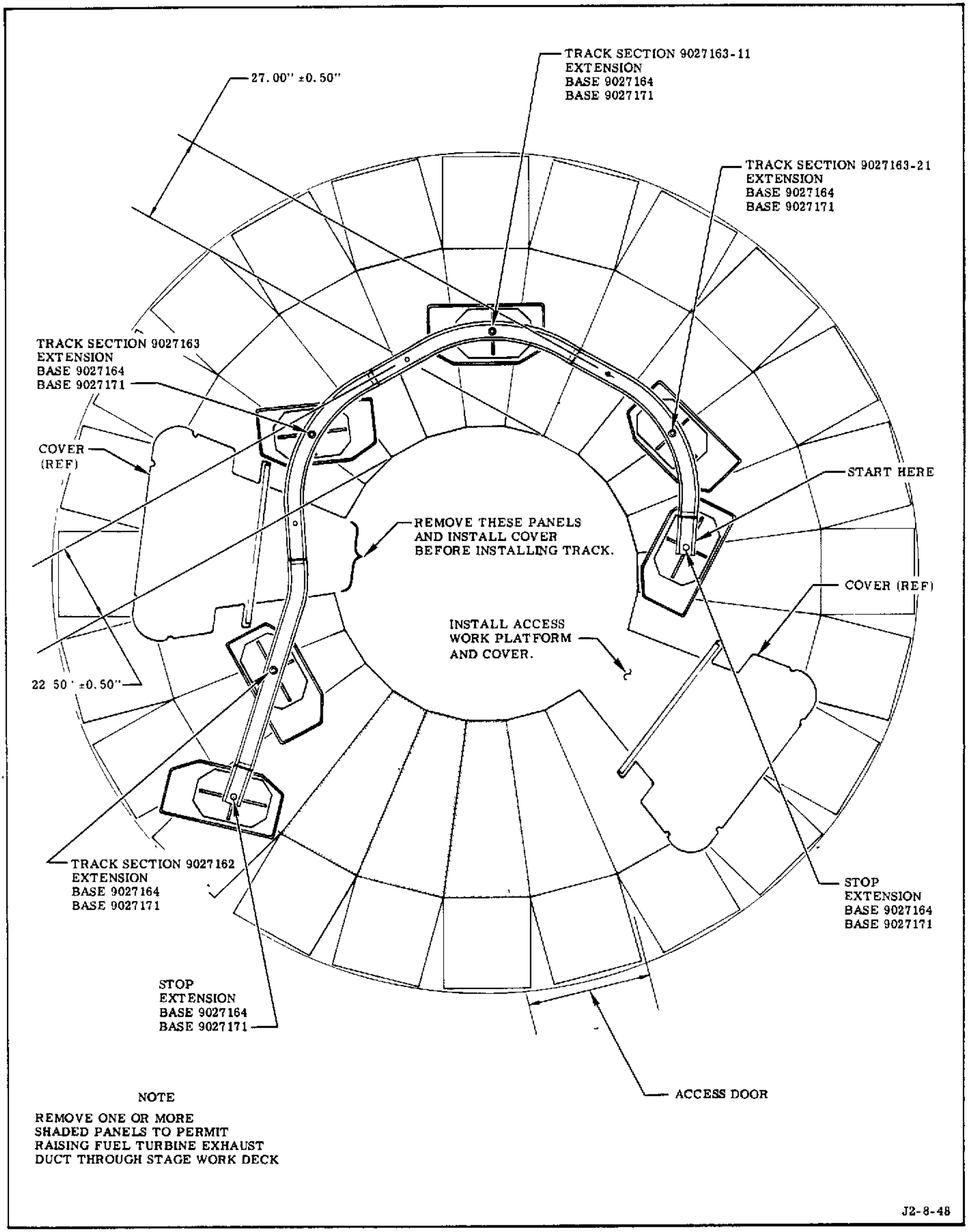


Figure 5-32. Location of Track Components for Removing Turbine Exhaust Duct (500-Series Stage)

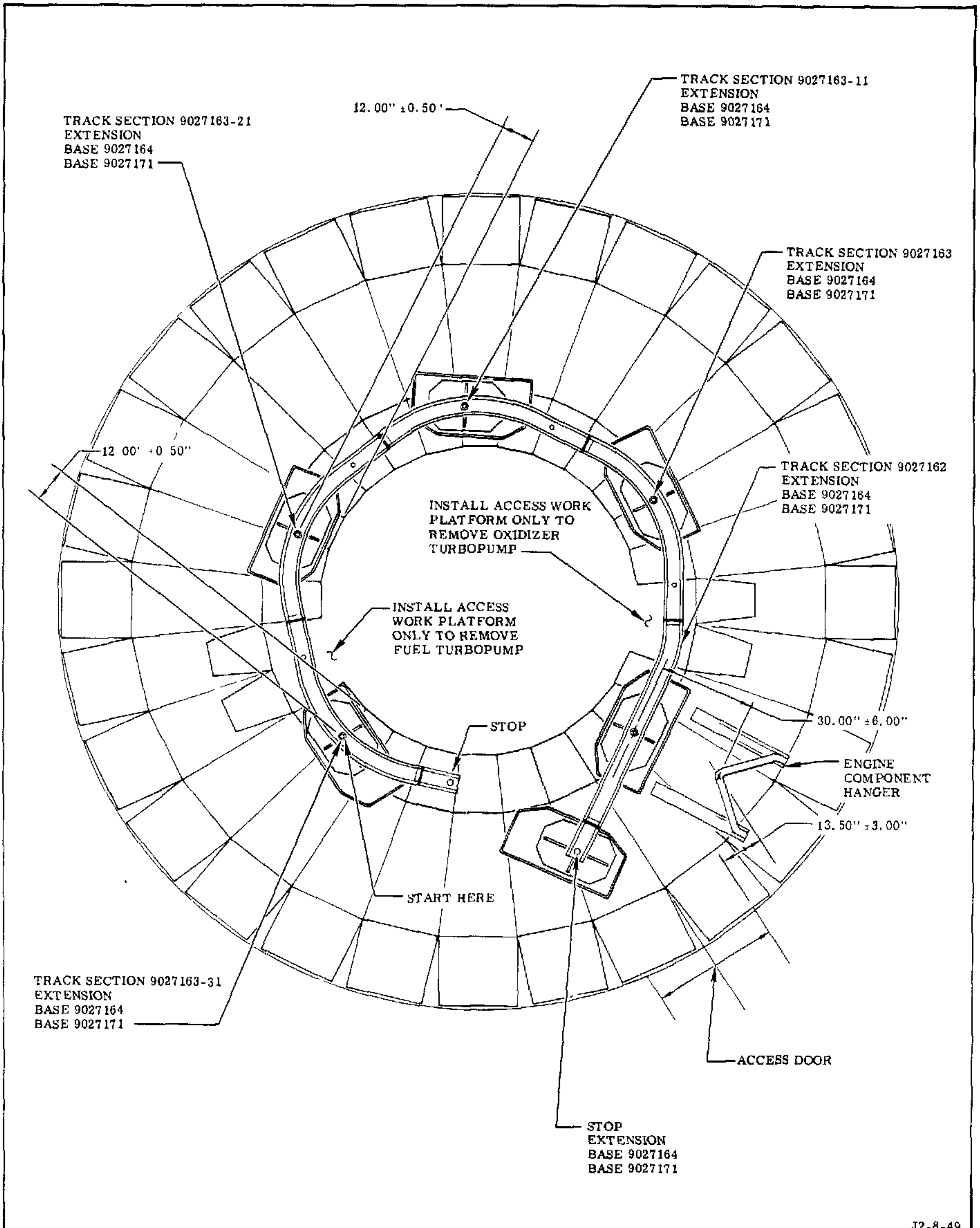


Figure 5-33. Location of Track Components for Removing Thrust Chamber Injector and Oxidizer and Fuel Turbopumps (200-Series Stage)

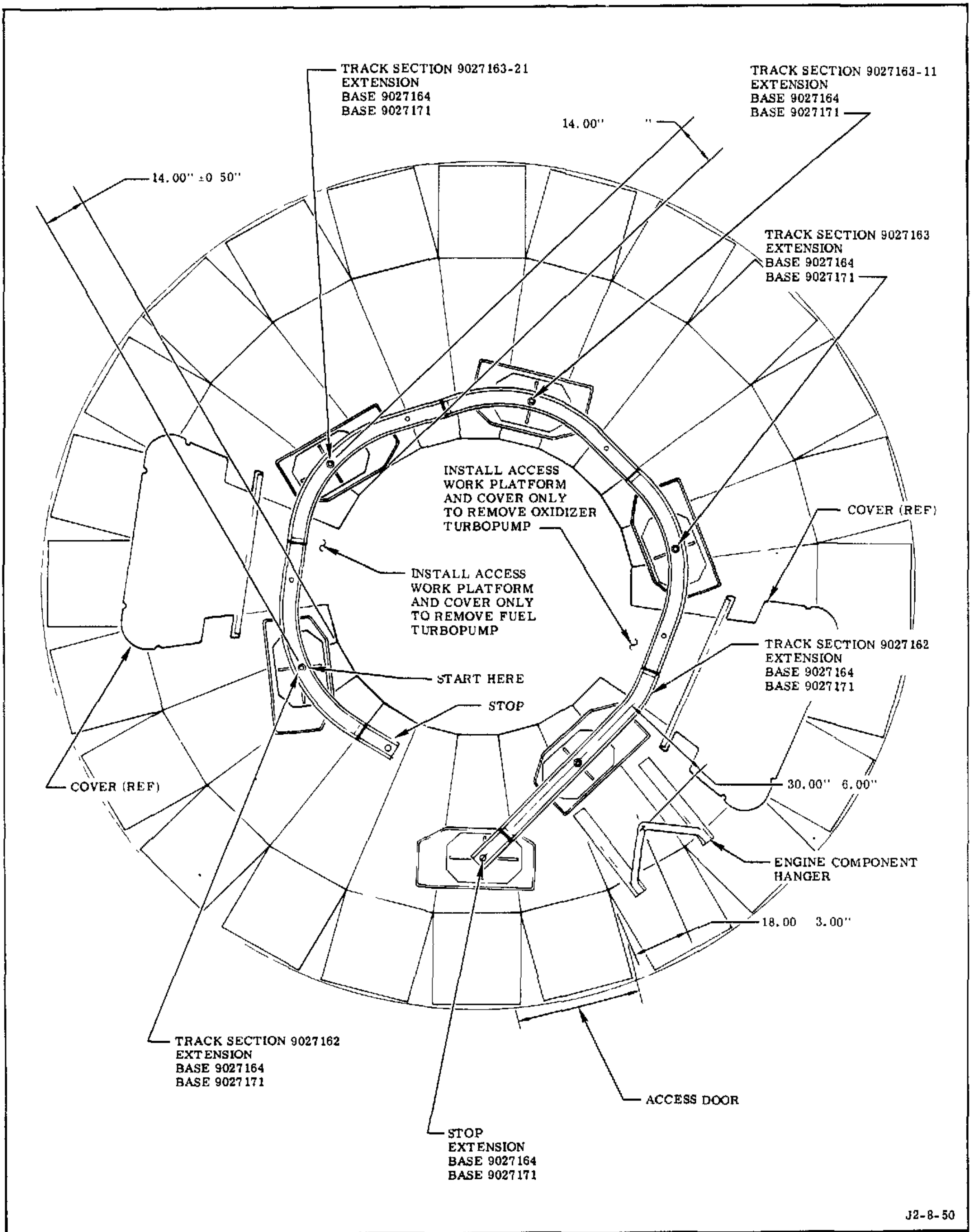


Figure 5-34. Location of Track Components for Removing Thrust Chamber Injector and Oxidizer and Fuel Turbopumps (500-Series Stage)

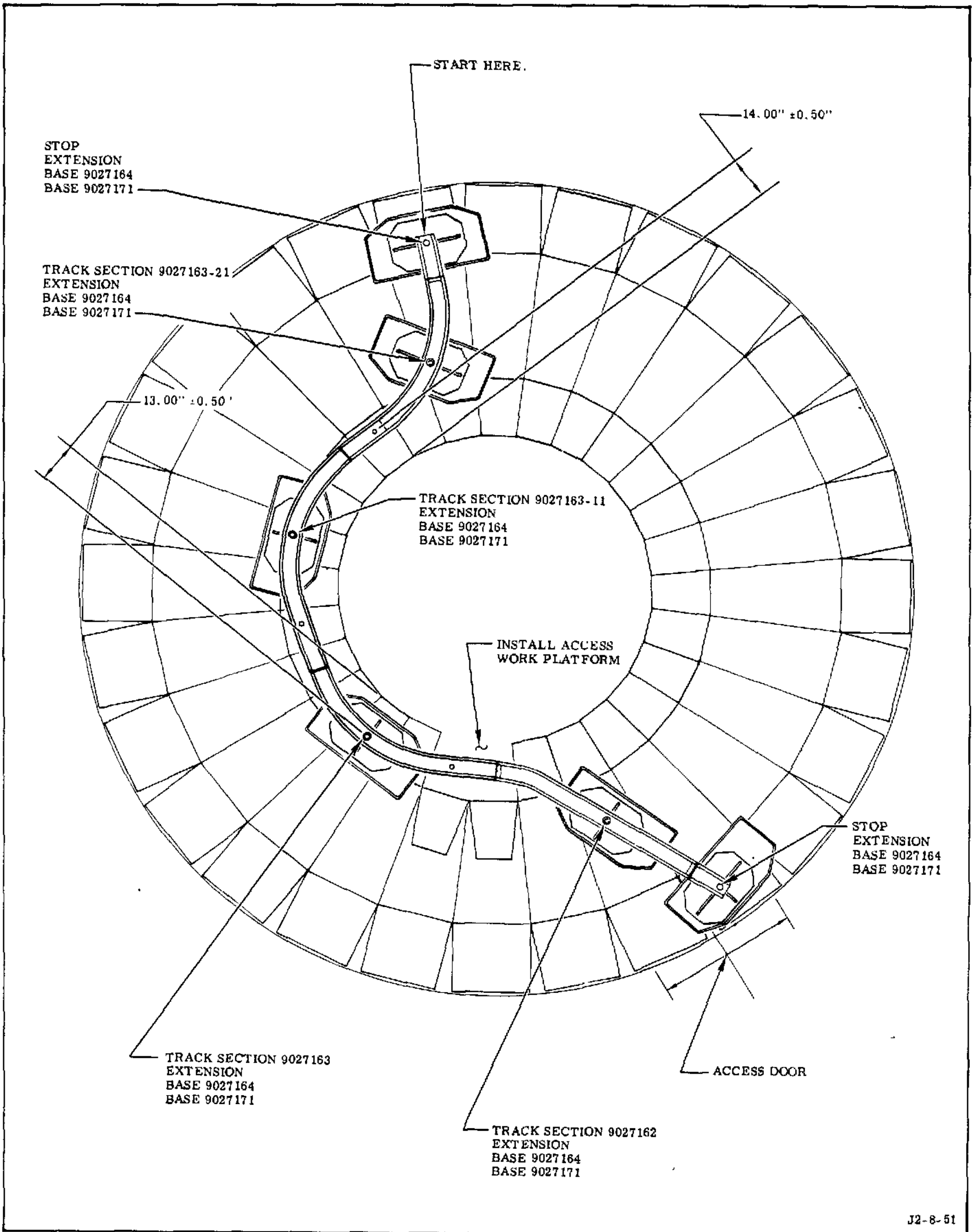


Figure 5-35. Location of Track Components for Removing Integral Hydrogen-Helium Start Tank and Auxiliary Flight Instrumentation Package (200-Series Stage)

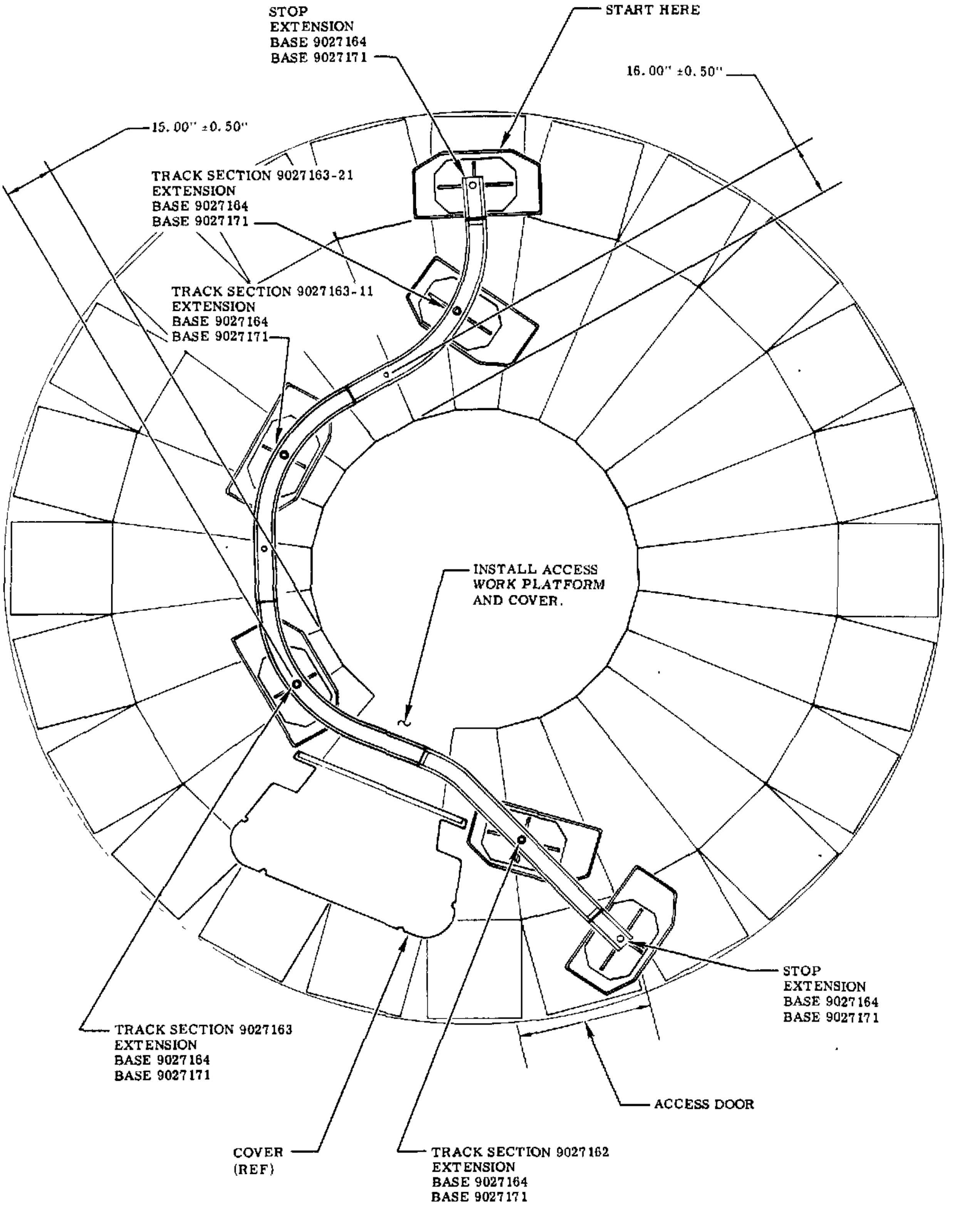


Figure 5-36. Location of Track Components for Removing Integral Hydrogen-Helium Start Tank and Auxiliary Flight Instrumentation Package (500-Series Stage)

Nomenclature	Part Number	Number Required to Install Track Illustrated in Figures				Shelf Number
		5-25, 5-26, 5-31, 5-32	5-27, 5-28	5-33, 5-34	5-29, 5-30, 5-35, 5-36	
Track section	9027162	1	1	1	1	4
Track section	9027163	1	1	1	1	4
Track section	9027163-11	1	1	1	1	4
Track section	9027163-21	1	1	1		4
Track section	9027163-31			1		4
Stop	9027156	2	2	2	2	4
Base	9027164	5	6	6	5	2/3
Turntable	9027101	1	1	1	1	2
Boom	9027051	1	1	1	1	2
Base	9027171	5	6	6	5	1
Extension	9027196	5	6	6	5	1
Support pin	9027161	5	6	6	5	1
Track pin	9027160	5	5	6	4	1

Figure 5-37. Parts Required to Install Tracks Illustrated in Figures 5-25 Through 5-36

k. Install turntable with controls positioned as required by removal procedure. Make sure brake is released (brake handle fully inboard) while installing turntable, and position turntable at or beyond nearest track support before allowing full weight of turntable to be applied to track.

l. Install remaining stop in same manner as track sections were installed.

m. Position base plates wherever possible to bear on 3 sections of stage work deck. Position base plates to bear fully on one section and equally on the two adjacent sections. Where base plates cannot be positioned to bear on 3 sections (located outboard where sections are wider) position base plates to bear equally on two sections.

n. Adjust track so that centerline of track is 9-3/8 ±1/4 inches from top of work deck and rolling surfaces of rails are not misalined by more than 0.010 inch. Adjust extensions, as necessary, to aline rail surfaces, maintaining track elevation within required height. If adjustment nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

o. Install boom on turntable, and handtighten 4 bolts that secure boom to turntable.

p. Install boom adapter if required by removal procedures.

5-20. INSTALLING HEAT SHIELD SUPPORT TURNBUCKLE. Installation of the heat shield support turnbuckle is required when the start tank or fuel turbine exhaust duct is removed or installed on the center engine (engine position 5). Obtain heat shield support turnbuckle 9027185 from compartment on shelf 3 of stowage cart assembly.

a. Between engine positions 2 and 3, adjacent to V-strut (stage), determine distance (to nearest 1/32 inch) between top surfaces of platform 9027190 and heat shield (stage). Dimension should be 10-1/2 ±1/8 inches. (See figure 5-38.)

WARNING

Applying weight to the heat shield with the V-strut or support turnbuckle disconnected can result in injury to personnel and damage to equipment.

b. Remove heat shield V-strut (stage) in accordance with applicable stage procedures, and install support turnbuckle (figure 5-38). Make sure no weight is applied to heat shield between the time V-strut is disconnected and support strut is installed.

c. Adjust support turnbuckle to properly position heat shield. (Refer to step a.)

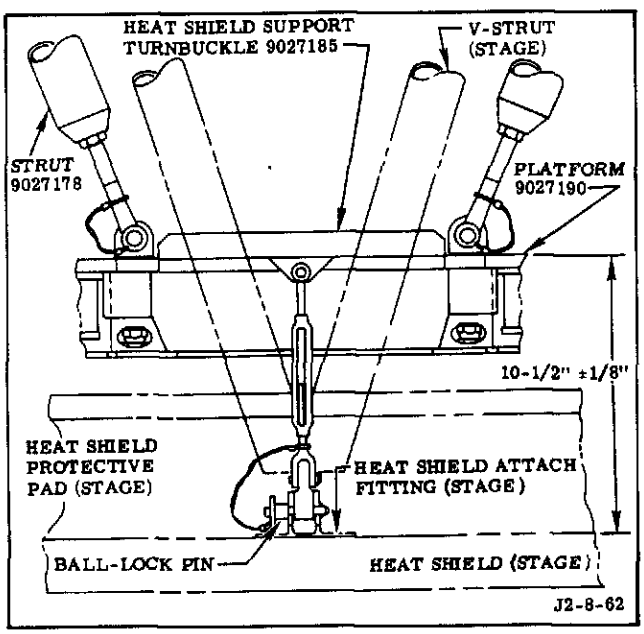


Figure 5-38. Installing Heat Shield Support Turnbuckle

5-21. REMOVING TRACK AND HOIST. Remove track and hoist in reverse order of installation except as follows:

WARNING

On SII stages, exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

- The track sections must be supported at all times during removal, to prevent injury to personnel and damage to equipment.

a. If track sections cannot be separated manually, insert a 1/2-inch-diameter rod, as a handhold, in the 17/32-inch-diameter horizontal hole in ends of track sections nearest joint, and pry track sections apart using wedge-shaped slot at track joint.

b. Place and secure all track and hoist parts in stowage cart assembly. (Refer to paragraph 5-4.)

5-22. REMOVING HEAT SHIELD SUPPORT TURNBUCKLE. Remove support turnbuckle in reverse order of installation except as follows:

WARNING

Applying weight to the heat shield with the V-strut (stage) or support turnbuckle disconnected can result in injury to personnel and damage to equipment.

a. Remove support turnbuckle and install heat shield V-strut in accordance with applicable stage procedures. Make sure no weight is applied to heat shield between the time support turnbuckle is removed and V-strut is installed. (See figure 5-38.)

5-23. ENGINE LOWERING SYSTEM.

5-24. The lowering system lowers the engine a maximum of 7 inches for removal of the thrust chamber injector and/or gimbal. The system consists of frames, beams, and brackets for attachment to stage structure, brackets for

attachment to the engine GSE mounting pads, and turnbuckles for interconnecting the two. The frames and beams are required for engine positions 1 through 4 only.

5-25. INSTALLING ENGINE LOWERING SYSTEM (SII STAGE, ENGINE POSITIONS 1 THROUGH 4). This procedure provides information for installing the lowering system and connecting it to the engine. Alinement of lowering system and engine lowering procedures are found in section II. When installed, the lowering system appears as shown in figure 5-39.

a. Obtain Engine Components Installer G4071 parts listed in figure 5-40. Make sure turnbuckle 9027226-11 is prepared for use. Turnbuckle must have adjustment mechanism and link installed. If in doubt whether turnbuckle is prepared, refer to paragraph 5-28. (Refer to paragraph 5-4 for information on unloading stowage cart.)

b. Obtain the following:

(1) Twelve Fist Grip Clips G429-1/4 (Crosby-Laughlin), or equivalent

(2) Two 16-18 foot lengths of 1/4-inch cable. Cable must be 6x19 or 7x19 galvanized or stainless steel with a minimum breaking strength of 6,000 pounds.

c. Remove hydraulic actuators from engine in accordance with applicable stage procedures.

d. Remove oxidizer and fuel inlet ducts. Refer to section III for procedures.

e. Disconnect HYDROGEN TANK PRESSURIZATION hose from flange at thrust chamber. Remove seal. Install closure on each flange. Closures must be certified clean for propellant system use.

f. Move disconnected end of HYDROGEN TANK PRESSURIZATION hose over fluid interface lines (toward start tank), and secure hose to fluid interface lines.

g. Attach bracket 9027232 to GSE mounting pad on oxidizer side of engine (figure 5-41).

h. Attach bracket 9027231 to GSE mounting pad on fuel side of engine with captive bolts. Torque bolts to 330-430 in-lb.

i. Install bracket 9027248 (figure 5-42). Frames shown in illustration are installed in next step.

j. Install frames 9027249-11 and 9027249-12 by attaching short arm of frames to hydraulic actuator upper attach brackets and frames to bracket 9027248 as shown in figure 5-42. If attached ball-lock pins cannot be used to secure frames to hydraulic actuator upper attach bracket (due to interference with stage structure), stage hydraulic actuator attach pins or suitable equivalents may be substituted.

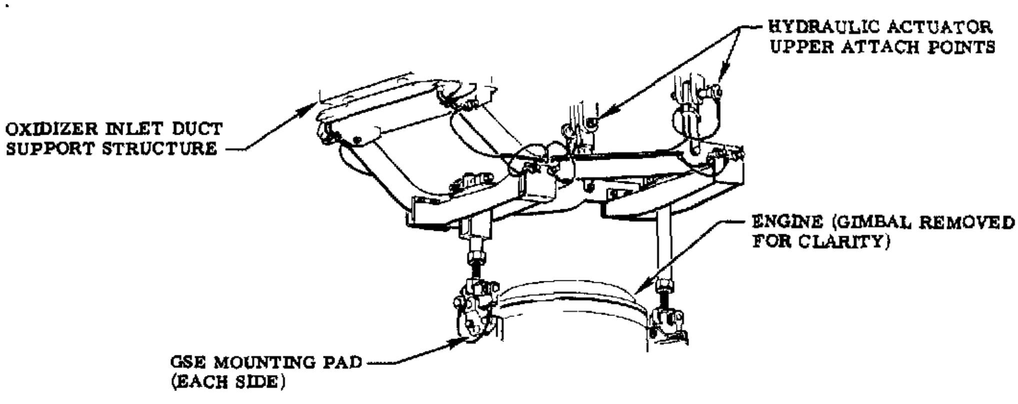


Figure 5-39. Lowering System Installed (Engine Positions 1 Through 4)

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number
Turnbuckle[(a)]	9027226-1		2
Bracket[(a)]	9027232		2
Turnbuckle	9027226-11		3
Bracket[(b)]	9027231		2
Bolts[(c)]	9027227	4	2
Frame	9027249-11		2
Frame	9027249-12		2
Bracket	9027248		2
Beam	9027258-1		2
Beam	9027258-11		2

(a) Stored assembled
(b) Stored assembled on either turnbuckle 9027226-2 (shelf 2) or turnbuckle 9027226-11 (shelf 3)
(c) Captive in bracket 9027231

Figure 5-40. G4071 Parts Required to Install Lowering System (Engine Positions 1 Through 4)

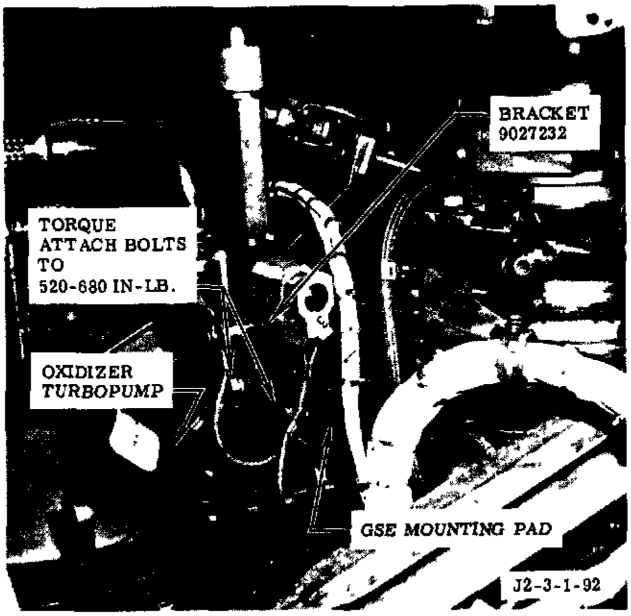


Figure 5-41. Bracket Installed (Oxidizer Side)

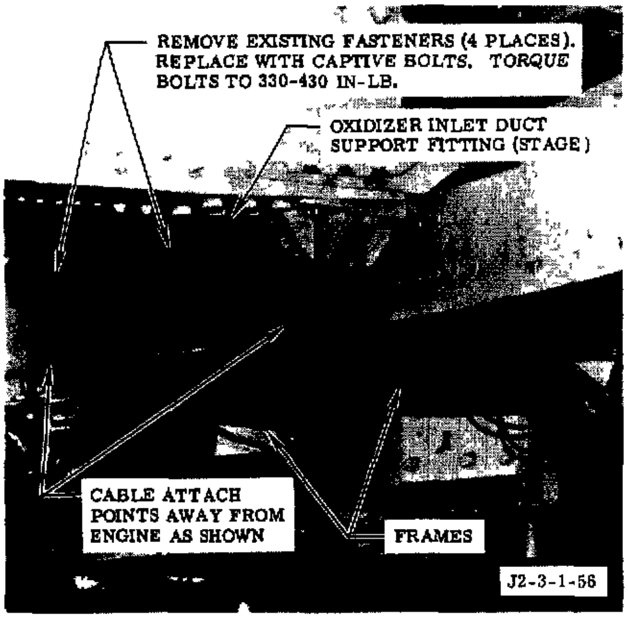


Figure 5-42. Bracket 9027248 Installed

WARNING

Missing roll pins can allow the turnbuckle to be extended beyond safe limits, causing injury to personnel and damage to equipment.

k. On the longer of the 2 turnbuckles, roll back rubber sleeve and make sure that roll pins are installed (figure 5-43). On the shorter turnbuckle, make sure that 2 roll pins are installed in threaded portions. One roll pin is visible on external surfaces of turnbuckle, and second roll pin is visible (when turnbuckle is extended) through 1/4-inch hole in lower portion of turnbuckle. Turnbuckles must not be used without roll pins installed. Replace rubber sleeve over slot on longer turnbuckle.

l. Adjust lower end of both turnbuckles to position shown in figure 5-44. This permits passage through limited access hole in beams.

m. Adjust shorter turnbuckle to its maximum extended length (roll pins prevent further extension); then shorten turnbuckle to one-half or less of its extendable length, making sure that ends of turnbuckle do not rotate, so that takeup is distributed evenly between the 2 threaded portions.

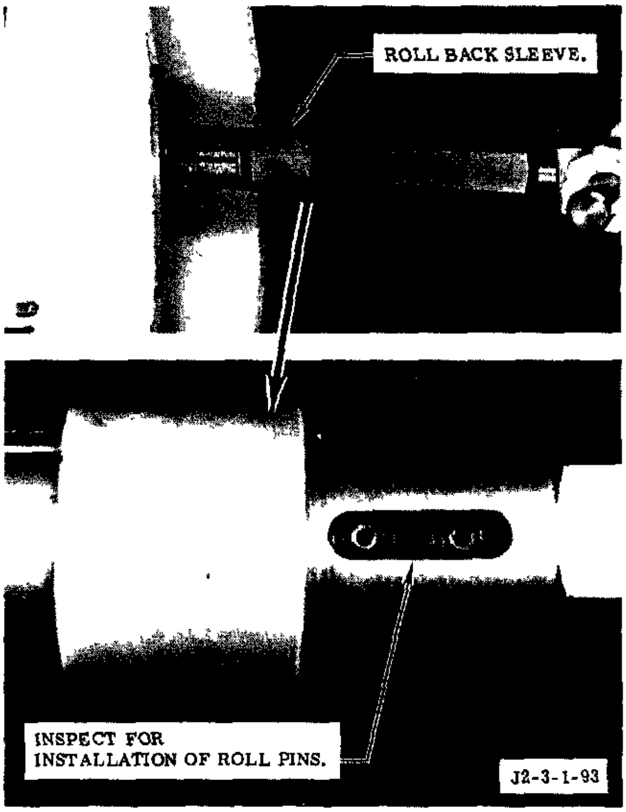


Figure 5-43. Inspecting for Roll-Pin Installation

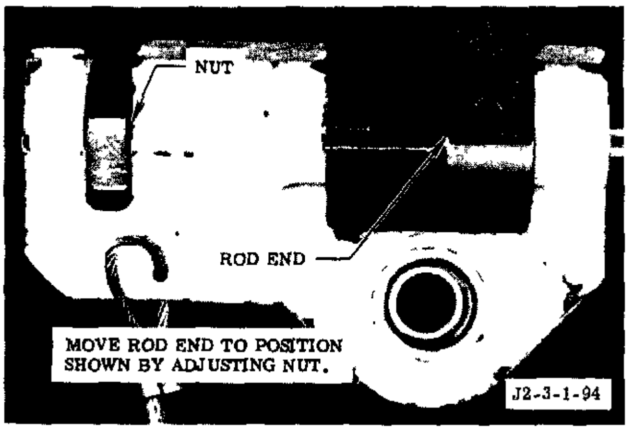


Figure 5-44. Adjusting Turnbuckle Prior to Installation

n. Attach turnbuckle 9027226-11 to beam 9027258-11 by inserting lower end of turnbuckle through beam (figure 5-45) and engaging upper adjusting mechanism to studs in beam.

o. Install turnbuckle and beam to frames on oxidizer side of engine. (See figure 5-46.)

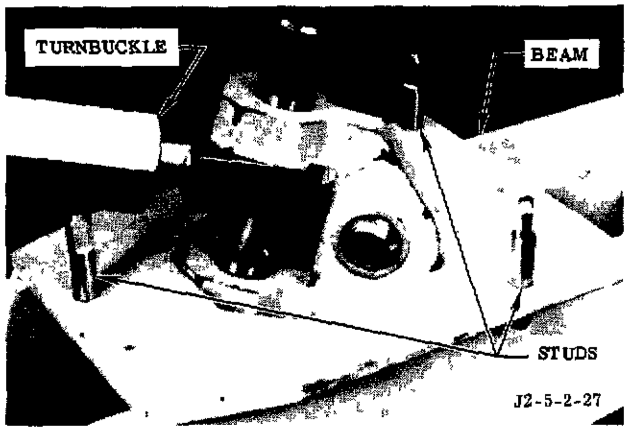


Figure 5-45. Inserting Turnbuckle Through Beam

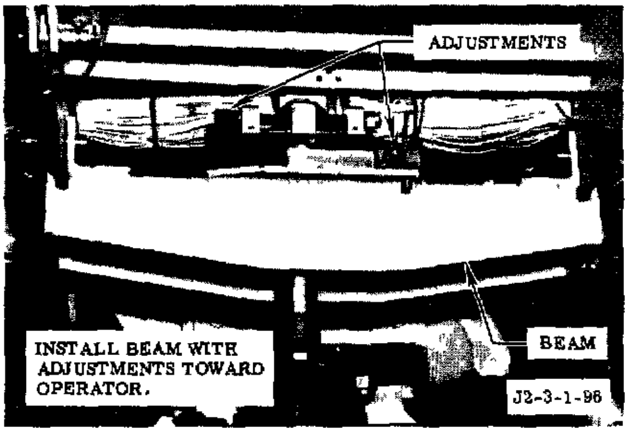


Figure 5-46. Beam Assembled to Frames

p. Adjust turnbuckle length, making sure equal distribution of threaded engagement is not disturbed, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

q. Adjust lower end of turnbuckle to center (within 1/32 inch) of adjustable range. This will place rod end directly over lower attach hole.

r. Shorten turnbuckle to take up slack.

s. Attach turnbuckle 9027226-1 to beam 9027258-1 and install turnbuckle and beam to frames, in same manner as previous assembly, except install on fuel side of engine. Adjustment at top of turnbuckle must be toward operator. (See figure 5-46.)

t. Make sure same number of threads (within one thread) show at each end of turnbuckle. Adjust if necessary.

u. Adjust turnbuckle length, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

v. Make sure turnbuckle rod end is centered. (Refer to step q.)

w. Shorten turnbuckle to take up slack.

x. Inspect installation. All ball-lock pins must be fully engaged, and bolts that secure brackets to oxidizer inlet support structure and thrust chamber must be seated and torqued.

y. Install cables as shown in figure 5-47 (SII-stage outboard engines). Adjust effective length of cables so that total slack will permit required lowering of engine, plus a maximum of 2 inches. However, under no condition is total slack to exceed 7 inches.

5-26. INSTALLING ENGINE LOWERING SYSTEM (SII STAGE, ENGINE POSITION 5). This procedure provides information for installing the lowering system and connecting it to the engine. Alinement of lowering system and engine lowering procedures are found in section II. When installed, the lowering system appears as shown in figure 5-48.

a. Obtain Engine Components Installer G4071 parts listed in figure 5-49. Make sure turnbuckle 9027226-2 is prepared for use. Turnbuckle must have adjustment mechanism and link installed. If in doubt whether turnbuckle is prepared, refer to paragraph 5-28. (Refer to paragraph 5-4 for information on unloading stowage cart.)

b. Obtain the following:

(1) Twelve Fist Grip Clips G429-1/4 (Crosby-Laughlin), or equivalent.

(2) Two 16-18 foot lengths of 1/4-inch cable. Cable must be 6x19 or 7x19 galvanized or stainless steel with a minimum breaking strength of 6,000 pounds.

c. Attach bracket 9027232 to GSE mounting pad on oxidizer side of engine (figure 5-41).

d. Attach bracket 9027231 to GSE mounting pad on fuel side of engine with 4 captive bolts. Torque to 330-430 in-lb.

WARNING

Missing roll pins can allow the turnbuckle to be extended beyond safe limits, causing injury to personnel and damage to equipment.

e. Roll back rubber sleeves on each turnbuckle and check that roll pins are installed (figure 5-43). Turnbuckles must not be used without roll pins installed. Replace rubber sleeves over slots.

f. Adjust lower end of both turnbuckles to position shown in figure 5-44. This permits passage through limited access hole in brackets.

g. Make sure same number of threads (within one thread) show at each end of both turnbuckles. Adjust if necessary.

h. Install bracket 9027259-1 as follows: Pass bracket between fuel inlet duct and web of fin on either side of duct. Rest bracket on lower flange. Make sure bracket is inboard as far as it will go and lying flat on flange with countersunk areas straddling flange bolts. (See figure 5-50.)

i. Secure bracket to flange by rotating clamping plates under flange and tightening clamp bolts until clamping plates are snug against flange.

j. Install turnbuckle 9027226-1 by passing it between fuel inlet duct and web of fin (figure 5-51) on either side of duct. Pass lower end of turnbuckle through bracket (figure 5-52) and engage studs on bracket. Installation will be simplified if turnbuckle is extended one-half or more of its extendable length before installation.

k. Adjust turnbuckle length, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber.

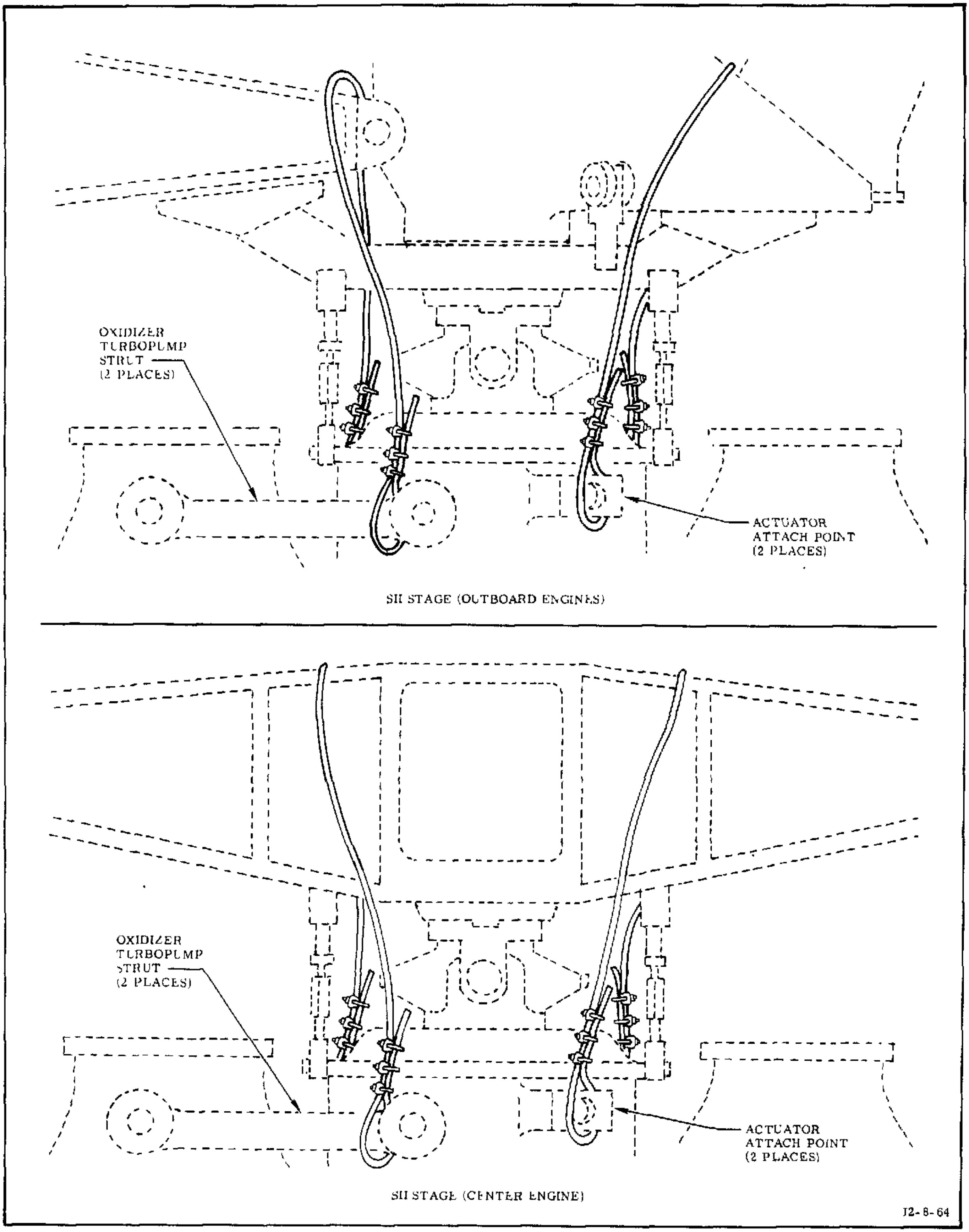
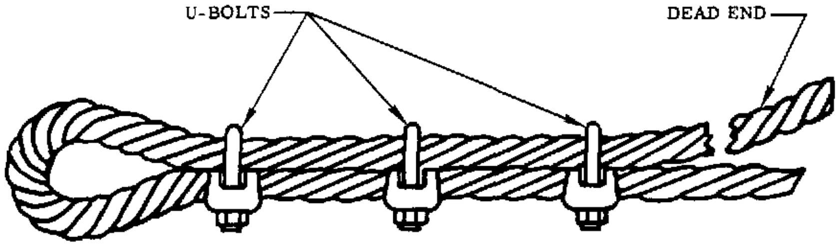
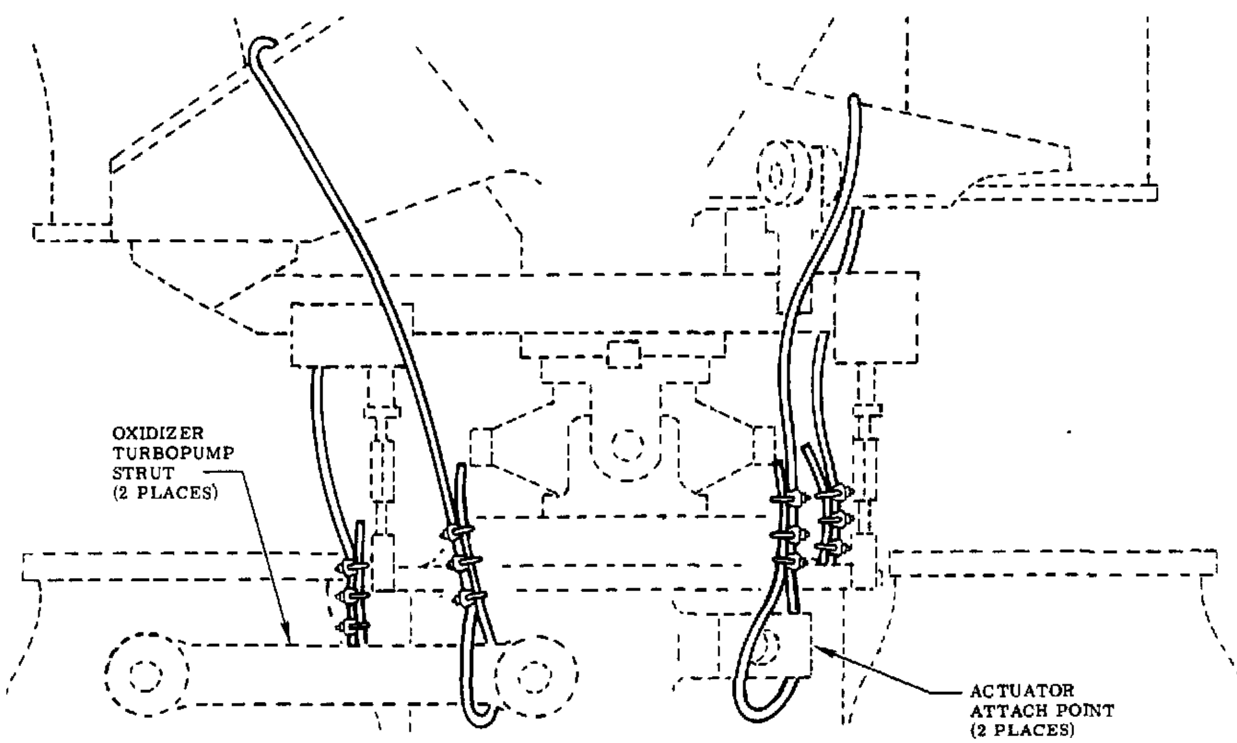


Figure 5-47. Installation of Safety Cables (Sheet 1 of 2)



1 INSTALL ALL CLIPS WITH U-BOLTS ON SHORT (DEAD) END OF CABLE.
2. SPACE CLIPS ON MINIMUM 1-1/2-INCH CENTERS.
3 TORQUE CLIP FURTHEST FROM LOOP TO 25-30 IN-LB. APPLY TORQUE INCREMENTALLY, KEEPING THREAD TAKEUP UNIFORM.
4 APPLY TENSION TO CABLE, AND WHILE CABLE IS UNDER TENSION, TORQUE (REFER TO STEP 3) REMAINING TWO CLIPS.

INSTALLATION OF FIST GRIP CLIPS



SIVB STAGE

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Figure 5-47. Installation of Safety Cables (Sheet 2 of 2)

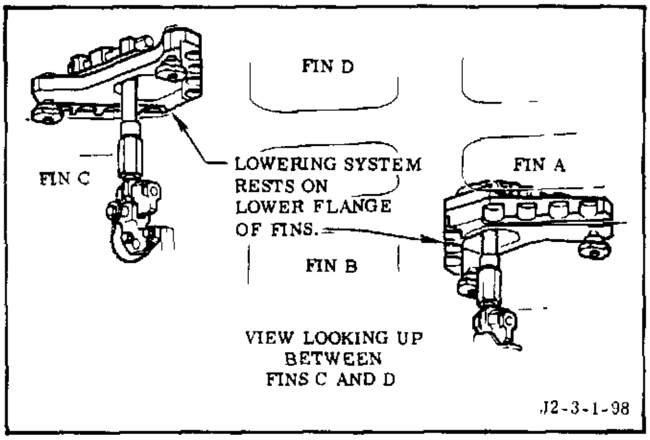


Figure 5-48. Lowering System Installed (Engine Position 5)

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number
Turnbuckle[a]	9027226-1		2
Bracket[a]	9027232		2
Turnbuckle[a]	9027226-2		2
Bracket[b]	9027231		2
Bolts[b]	9027227	4	2
Bracket	9027259-1		2
Bracket	9027259-2		2

(a) Stored assembled
(b) Captive in bracket 9027231

Figure 5-49. G4071 Parts Required to Install Lowering System (Engine Position 5)

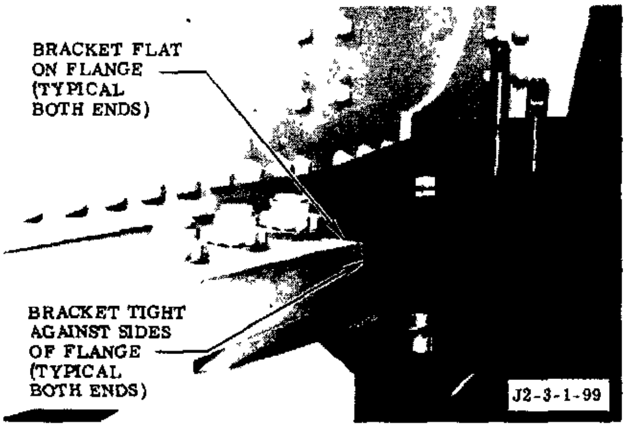


Figure 5-50. Bracket Installed (Fuel Side)

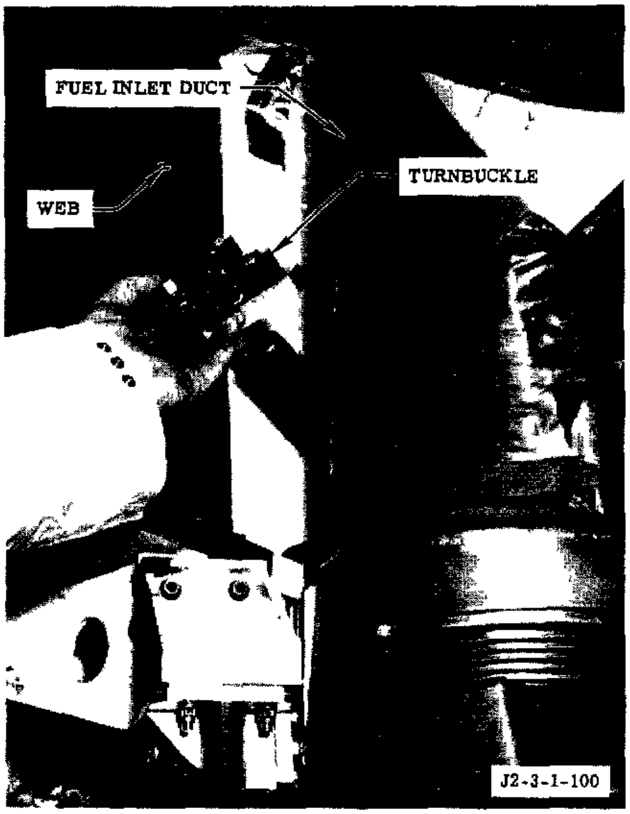


Figure 5-51. Installing Turnbuckle

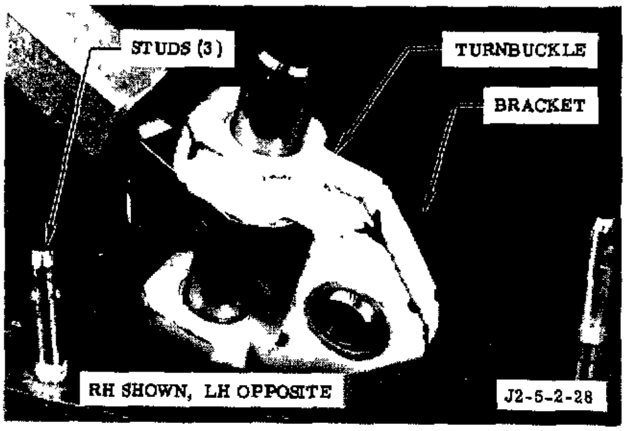


Figure 5-52. Assembling Turnbuckle to Bracket

l. Adjust lower end of turnbuckle to center (within 1/32 inch) of adjustable range. This will place rod end directly over lower attach hole.

m. Shorten turnbuckle to take up slack.

n. Inspect installation. Bracket must be firmly seated and clamped to flanges, turnbuckle must be engaged to bracket studs, ball-lock pin must be fully engaged, and bolts securing bracket to thrust chamber must be seated and torqued.

o. Install bracket 9027259-2 on lower flange of fins on oxidizer side of engine in same manner bracket 9027259-1 was installed.

p. On turnbuckle 9027226-2, remove bolt and separate turnbuckle from upper adjusting mechanism. (See figure 5-53.) Space limitations prevent installation of the assembled turnbuckle.

q. Install disassembled turnbuckle by passing it between oxidizer inlet duct and web of fin on either side of duct, passing lower end through bracket (see figure 5-52), and engaging upper adjusting mechanism to pins on bracket.

r. Assemble turnbuckle by reinstalling and tightening bolt removed in step p. Do not exceed 155 in-lb on bolt.

s. Adjust turnbuckle length, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

t. Make sure turnbuckle rod end is centered. (Refer to step l.)

u. Shorten turnbuckle to take up slack.

v. Inspect installation. Bracket must be firmly seated and clamped to flanges, turnbuckle must be engaged to pins of bracket, ball-lock pin must be fully engaged, and bolts that secure bracket to thrust chamber must be seated and torqued.

w. Disconnect and remove stage stiff arms from engine in accordance with applicable stage procedures.

x. Install cables as shown in figure 5-47 (SII-stage center engine). Adjust effective length of cables so that total slack will permit required lowering of engine, plus a maximum of 2 inches. However, under no condition is total slack to exceed 7 inches.

5-27. INSTALLING ENGINE LOWERING SYSTEM (SIVB STAGE). This procedure provides information for installing the lowering system and connecting it to the engine. Engine lowering procedures are found in section II. When installed, the lowering system appears as shown in figure 5-54.

a. Obtain Engine Components Installer G4072 parts listed in figure 5-55.

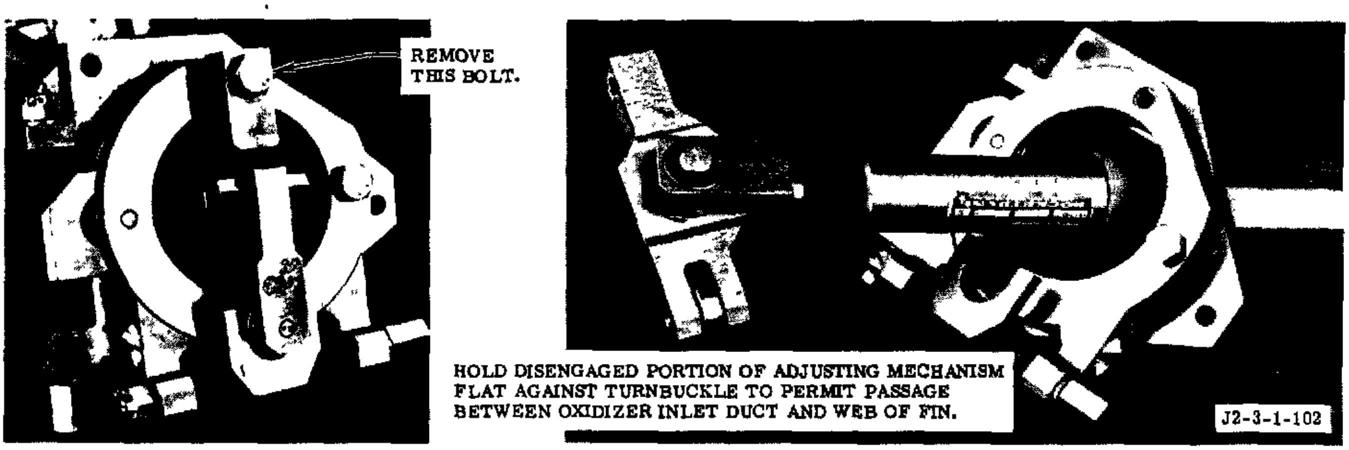


Figure 5-53. Preparing Turnbuckle for Installation (Oxidizer Side)

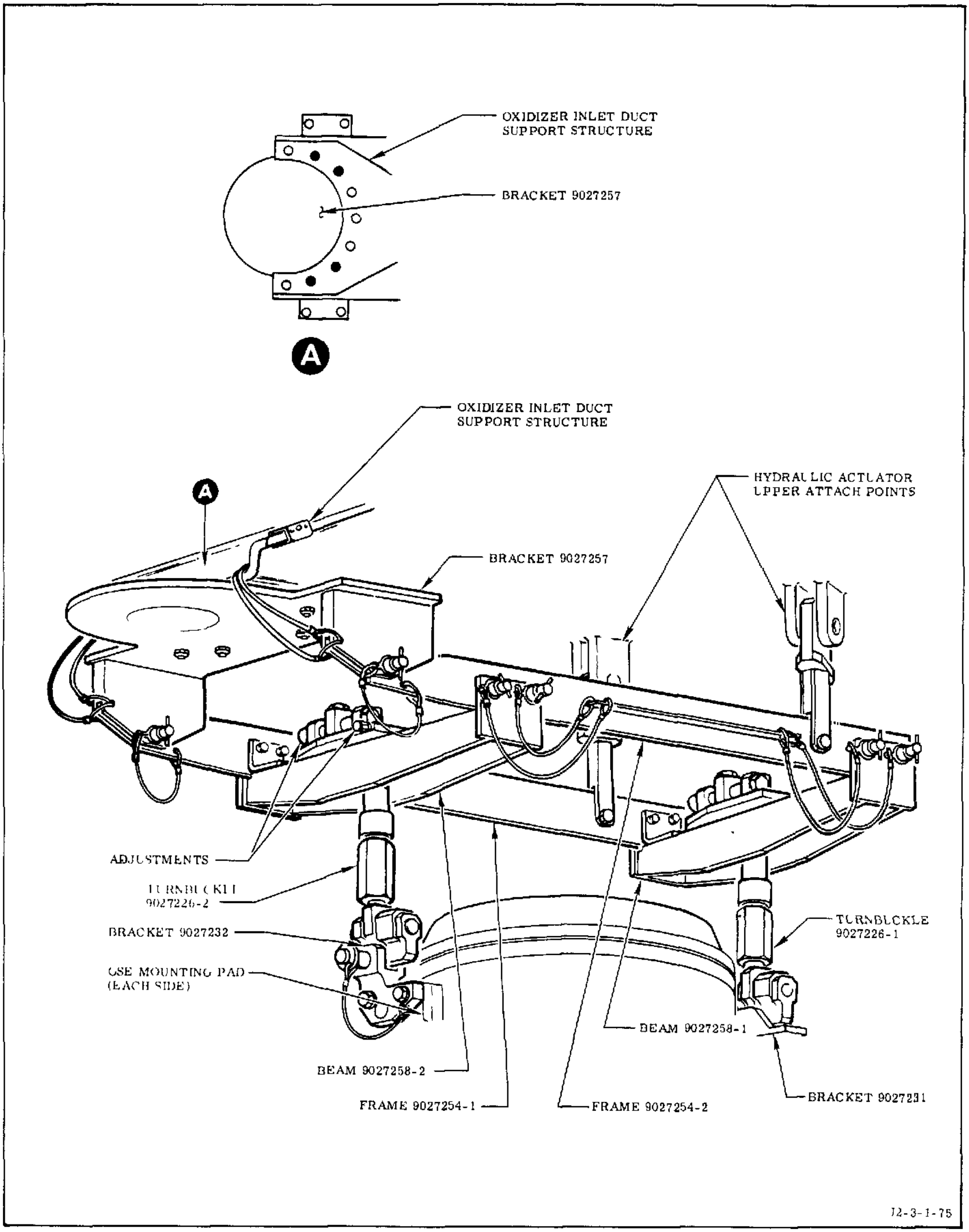


Figure 5-54. Lowering System Installed (SIVB)

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number
Turnbuckle[a]	9027226-1		2
Bracket[a]	9027232		2
Turnbuckle[a]	9027226-2		2
Bracket[a]	9027231		2
Bolts[b]	9027227	4	2
Frame	9027254-1		2
Frame	9027254-2		2
Bracket	9027257		2
Beam	9027258-1		2
Beam	9027258-2		2

(a) Stored assembled
(b) Captive in bracket 9027231

Figure 5-55. G4072 Parts Required to Install Lowering System (SIVB)

b. Obtain the following:

(1) Twelve Fist Grip Clips G429-1/4 (Crosby-Laughlin), or equivalent.

(2) Two 16-18 foot lengths of 1/4-inch cable. Cable must be 6x19 or 7x19 galvanized or stainless steel with a minimum breaking strength of 6,000 pounds.

c. Remove hydraulic actuators from engine in accordance with applicable stage procedures.

d. Remove oxidizer and fuel inlet ducts. (Refer to section III for procedures.)

e. Attach bracket 9027232 to GSE mounting pad on oxidizer side of engine (figure 5-54). Torque bolts to 520-680 in-lb.

f. Attach bracket 9027231 to GSE mounting pad on fuel side of engine with 4 captive bolts. Torque bolts to 330-430 in-lb.

g. Remove 4 bolts from oxidizer inlet support structure that match boltholes in bracket 9027257. (See figure 5-54.)

h. Install bracket 9027257. Torque bolts to 120-155 in-lb. Install bolts from top (stage) side, and shim bolts with washers, as necessary, to prevent bolt threads from bottoming while permitting bolt to protrude through bracket for full engagement with nut. Install nuts and torque to 120-155 in-lb.

i. Install frames 9027254-1 and 9027254-2 as shown in figure 5-54.

j. Shorten both turnbuckles to minimum length.

WARNING

Missing roll pins can allow the turnbuckle to be extended beyond safe limits, causing injury to personnel and damage to equipment.

k. Roll back rubber sleeve on each turnbuckle, and check that roll pins are installed. (See figure 5-43.) Turnbuckles must not be used without roll pins installed. Replace rubber sleeves over slots.

l. Adjust lower end of both turnbuckles to position shown in figure 5-44. This permits passage through limited access hole in beams.

m. Attach turnbuckle 9027226-2 to beam 9027258-2 by inserting lower end of turnbuckle through beam (figure 5-45) and engaging upper adjusting mechanism to studs in beam.

n. Install turnbuckle and beam to frame on oxidizer side of engine. Make sure that adjustments at top of turnbuckle are toward operator. (See figure 5-54.)

o. Make sure same number of threads (within one thread) show at each end of turnbuckle; adjust, if necessary.

p. Lengthen turnbuckle, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

q. Adjust lower end of turnbuckle to center (within 1/32 inch) of adjustable range. This will place rod end directly over lower attach hole.

r. Shorten turnbuckle to take up slack.

s. Attach turnbuckle 9027226-1 to beam 9027258-1, and install turnbuckle and beam to frames in same manner as previous assembly, except install on fuel side of engine.

t. Make sure same number of threads (within one thread) show at each end of turnbuckle; adjust, if necessary.

u. Lengthen turnbuckle, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

v. Make sure turnbuckle rod end is centered. (Refer to step q.)

w. Shorten turnbuckle to take up slack.

x. Inspect installation. All ball-lock pins must be fully engaged. Bolts that secure brackets to oxidizer inlet support structure and thrust chamber must be seated and torqued.

y. Install cables as shown in figure 5-47 (SIVB stage). Adjust effective length of cables so that total slack will permit required lowering of engine, plus a minimum of 2 inches. However, under no condition is total slack to exceed 7 inches.

5-28. PREPARING TURNBUCKLES FOR USE (SII STAGE). Turnbuckles 9027226-2 and 9027226-11 use common parts that may require exchanging before the required turnbuckle is usable. Exchanging these parts requires no special information or tools. See figure 5-56 for an illustration of parts to be exchanged and their attach points.

5-29. REMOVING ENGINE LOWERING SYSTEM. Remove engine lowering system in reverse order of installation. When reconnecting HYDROGEN TANK PRESSURIZATION hose, install seal, and cross-torque bolts to 30-40 in-lb.

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in injury to personnel and damage to equipment.

NOTE

Loads applied to the heat shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

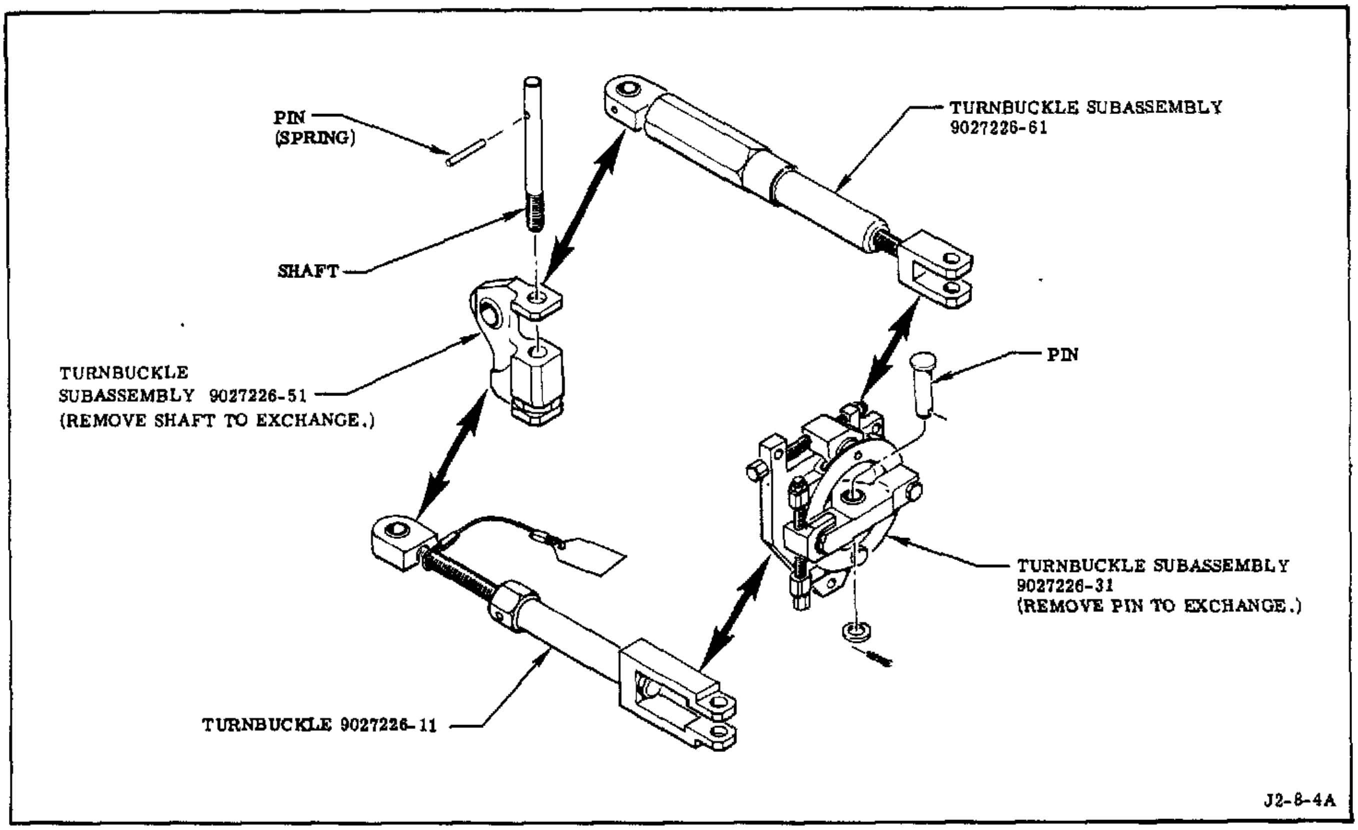


Figure 5-56. Preparing Turnbuckles for Use

5-30. INTERNAL ACCESS PLATFORM.

5-31. The internal access platform allows a technician to stand inside the thrust chamber for installation of the thrust chamber throat plug. When installed and unfolded, the platform provides a level surface for standing. The platform has a maximum working load of 250 pounds, sufficient for one man and the throat plug.

5-32. INSTALLING INTERNAL ACCESS PLATFORM. The internal access platform is required to remove or install the thrust chamber throat plug. Obtain internal access base 9027219 and internal access platform 9027211 from shelf 3 of stowage cart.

WARNING

Helium may be trapped in the thrust chamber. An air supply or self-contained air-breathing apparatus must be used to prevent injury or death to personnel.

CAUTION

Since access to the thrust chamber interior over the stage bulkhead is limited, components and tools must be handled with extreme care to prevent damaging the components or bulkhead when installing the internal access platform.

a. Provide access through stage work deck, large enough to permit passage of internal access platform 9027211.

b. Remove closure from thrust chamber exit flange.

c. With 4 pads up, place internal access base on circumference of thrust chamber exit flange (any position) and aline boltholes. Install captive bolts. Torque bolts to 120-155 in-lb.

d. Install internal access platform in position shown in figure 5-57 as follows:

(1) Move internal access platform in a horizontal position below thrust chamber exit flange and then to a vertical position within thrust chamber interior.

(2) Lift internal access platform and place protectors over adapters on internal access base; then carefully rest top of internal access platform against thrust chamber tubes.

(3) Remove ball-lock pins.

(4) Push step upward until ball-lock pin holes aline; then reinstall ball-lock pins.

5-33. REMOVING INTERNAL ACCESS PLATFORM. Remove internal access platform in reverse order of installation.

CAUTION

Handle components and tools with extreme care when removing internal access platform, since access to the thrust chamber interior over the stage bulkhead is limited, and damage to components or bulkhead can result.

5-34. ACCESS WORK PLATFORM.

5-35. The access platform enables access to engine components below the stage work deck by providing a work surface approximately 5 feet below the stage work deck. The access platform accommodates one man and installs through the opening provided when two adjacent pie-shaped sections of the work deck are removed. On 500-series stages where removal of the two pie-shaped sections leaves a larger-than-required opening, a cover is provided to safely cover the excess.

5-36. INSTALLING ACCESS WORK PLATFORM.

a. Obtain frames 9024598-1 and 9024598-2 from shelf 5 and platform 9025848 from shelf 4 of Engine Components Installer G4072 stowage cart. If access work platform is to be installed in a 500-series stage, obtain cover 9027216 from shelf 5.

b. Insert frames into sockets in platform and secure frames with attached ball-lock pins. Frames are to be installed with the padded flanges outboard and the struts (braces) at the wide end of the platform.

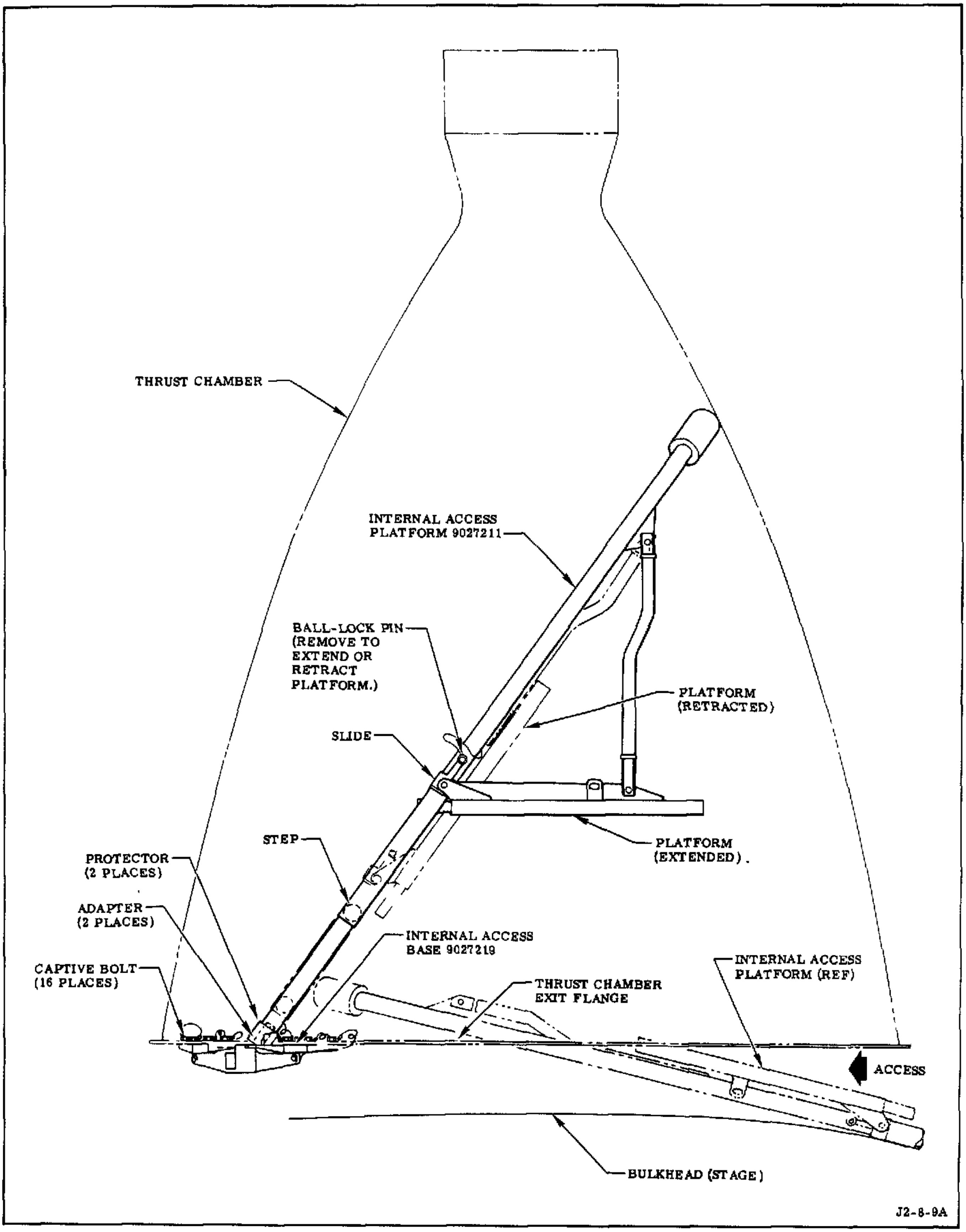


Figure 5-57. Installing Internal Access Platform

c. Attach the 2 struts (braces) to their respective attach points on the opposite frame.

d. Remove the 2 required adjacent pie-shaped sections of the work deck in accordance with stage procedures.

e. If access work platform is being installed in a 500-series stage, place cover over widest (outboard) end of opening. Place cover into opening with the side containing 3 square tube pieces down. Slide cover inboard as far as it will go.

f. Make sure small hinged extension of platform is folded back onto main portion of platform.

g. Hold short spring-loaded arms at top of access work platform fully inboard and carefully lower platform into opening provided by removal of pie sections until padded sections rest on stage work deck. Make sure platform does not contact engine.

WARNING

If spring-loaded arms are not fully outboard or securely against lower surface of work deck, an unstable condition will exist that can result in injury to personnel or damage to equipment.

h. Release spring-loaded arms and force arms outboard until they stop or are securely against lower surface of work deck.

i. Rotate small hinged section of platform to provide additional work surface.

5-37. REMOVING ACCESS WORK PLATFORM. Remove access work platform in reverse order of installation (paragraph 5-36). Make sure small hinged extension of platform is folded back onto main portion of platform before removing access work platform.

5-38. ELEVATED TRACK (SIVB STAGE).

5-39. The elevated track in conjunction with the hoist provides the capability of lifting or lowering engine components, to transfer the component from or to the stage.

5-40. INSTALLING ELEVATED TRACK (200 SERIES).

a. Obtain a carpenter level and the following parts from engine components installer set 9026252:

(1) Base 9026990 (two required)

(2) Extension 9026991

(3) Extension 9026991-11

(4) Support pin 9027161

(5) Stop 9027156

b. Obtain one extension 9027196 from shelf 1 of Engine Components Installer G4072.

c. Move hoist to a position on the track where none of the weight of the hoist will be applied to track section 9027162 (nearest stage access door). Apply hoist brake.

d. Remove stop and track section 9027162 (nearest stage access door). Retain track section, extensions, track pins, support pins, one base 9027171, and one base 9027164 for use in assembling elevated track. Retain remainder of parts for reuse when lower track is reassembled.

e. Remove hoist from lower track and hand-carry hoist outside of stage.

f. Assemble and position elevated track as shown in figure 5-58 except do not install stop at outboard end of track. Observe the following:

(1) Secure extensions 9027196 to track or stops with support pins. Tighten pin sufficiently to seat heads.

(2) Secure track sections to stop with track pins. Make sure pins do not protrude beyond side of stops.

(3) Level (use carpenter level) track by adjusting height of extensions 9027196. If extension adjustment nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp). To compensate for deflection of stage work deck, it may be necessary to pin extension 9026991-11 to base 9026990, using lower hole of each pair of holes.

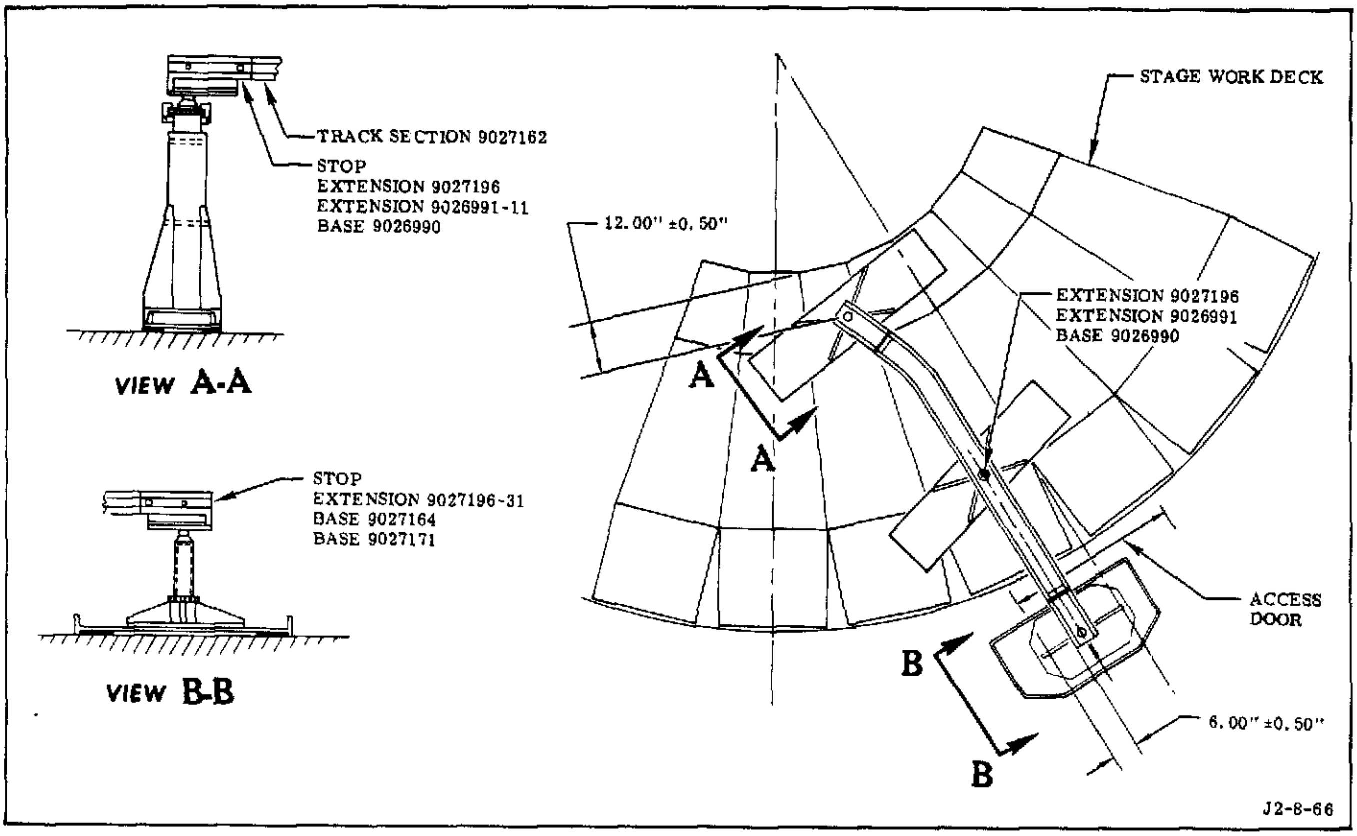


Figure 5-58. Location of Track Components for Elevated Track (200-Series Stage)

(4) Lock extensions 9026991 and 9026991-11 to extensions 9027196 by securing locks into spanner wrench holes of adjustment nuts.

g. Install turnbuckle onto track with controls leading. Position hoist at or beyond first track support before allowing full weight of hoist to be applied to track. Apply hoist brake.

h. Install remaining stop, bases, and extension. (See figure 5-58.) Adjust extension as required to maintain track level. If extension adjustment nut is difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

5-41. INSTALLING ELEVATED TRACK (500 SERIES).

a. Obtain a carpenter level and the following parts from engine components installer set 9026252:

(1) Base 9026990 (two required)

(2) Extension 9026991

(3) Extension 9026991-11

(4) Support pin 9027161

(5) Stop 9027156

(6) Support 9026993

b. Obtain one extension 9027196 from shelf 1 of Engine Components Installer G4072.

c. Move hoist to a position on the track where none of the weight of the hoist will be applied to track section 9027162 (nearest stage access door). Apply hoist brake.

d. Remove stop and track section 9027162 (nearest stage access door). Retain track section, extensions, track pins, support pins, one base 9027171, and one base 9027164 for use in assembling elevated track. Retain remainder of parts for reuse when lower track is reassembled.

e. Remove hoist from lower track and hand-carry hoist outside of stage.

f. Assemble and position elevated track as shown in figure 5-59. Observe the following:

(1) Start track assembly with support and stop at outboard end of illustration (figure 5-59).

(2) Secure extensions 9027196 to track or stops with support pins. Tighten pin sufficiently to seat heads.

(3) Secure track sections to stop with track pins. Make sure pins do not protrude beyond side of stops.

(4) Level (use carpenter level) track by adjusting height of extensions 9027196. If extension adjustment nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp). To compensate for deflection of stage work deck, it may be necessary to pin extension 9026991-11 to base 9026990, using the lower hole of each pair of holes.

(5) Lock extensions 9026991 and 9026991-11 to extensions 9027196 by securing locks into spanner wrench holes of adjustment nuts.

g. Remove support and stop at outboard end of track.

h. Install turnbuckle onto track with controls leading. Position hoist at or beyond first track support before allowing full weight of hoist to be applied to track. Apply hoist brake.

i. Replace support and stop on outboard end of track.

5-42. REMOVING ELEVATED TRACK AND REASSEMBLING LOWER TRACK.

a. Position hoist near inboard end of track and apply hoist brake.

b. Remove stop and support (500 series), or stop, extension, and bases (200 series) from outboard end of track.

c. Remove hoist from track, and temporarily store hoist outside of stage. While removing hoist, do not allow the weight of the hoist to be applied to unsupported end of track section.

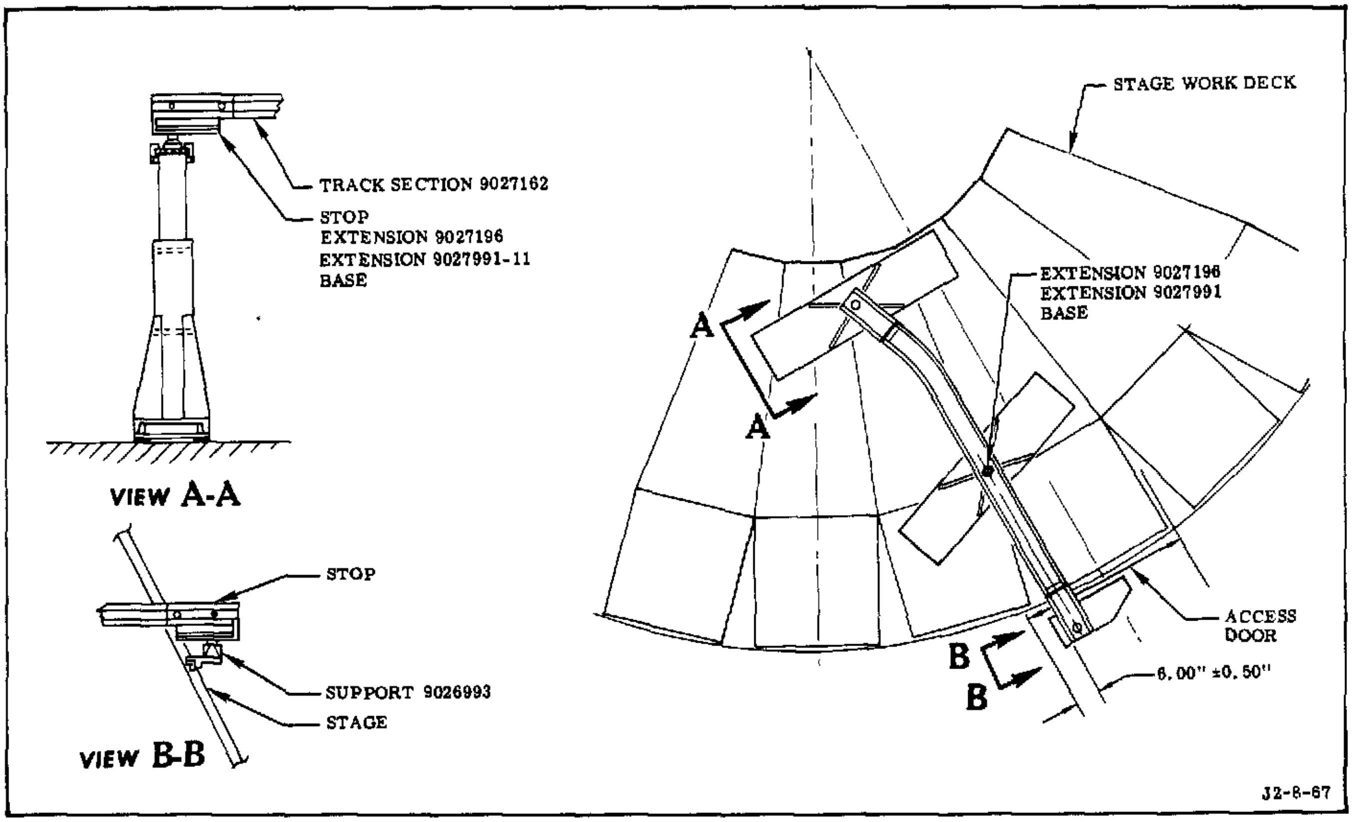


Figure 5-59. Location of Track Components for Elevated Track (500-Series Stage)

d. Disassemble remainder of track.

e. Reinstall track section 9027162 with necessary bases and extensions, to original lower configuration. Refer to figure 5-33 (SIVB, 200 series) or figure 5-34 (SIVB, 500 series) for illustration of original track configuration. Do not install stop at this time.

f. Hand-carry hoist into stage, and install hoist on track. Install hoist with controls positioned, as required, in removal procedures of component being installed. Position hoist at or beyond first track support before allowing the weight of the hoist to be applied to track.

g. Install stop, extension, and bases on end of track.

h. Make sure support pins are tightened sufficiently to seat heads of pins, and track pins do not protrude beyond outside surfaces of track.

i. Level reinstalled track section to match existing track by adjusting extensions. If extension adjustment nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

j. Return surplus parts from elevated track to their respective installer or installer set.

SECTION VI

IN-PLACE TUBE WELDING

WARNING

SINGLE HEAD SPECIAL TOOL KIT G3127 AND AUTOMATIC INERT GAS ARC WELDER G3128 MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

6-1. SCOPE. This section contains requirements for performing tube welds on the J-2 Rocket Engine and step-by-step procedures for operating Automatic Inert Gas Arc Welder G3128 and Single Head Special Tool Kit G3127 provided to accomplish this task.

6-2. PHILOSOPHY GOVERNING IN-PLACE TUBE WELDING.

6-3. The welder produces a continuous circumferential melt-thru welded joint on stationary in-place engine tubes up to one-inch in diameter. Welds of this type cannot be 100-percent inspected. In-place tube welds preclude visual inspection of the interior surfaces and cannot be X-rayed to determine weld acceptability. To substitute for the inability to inspect, procedures developed through intensive testing govern all aspects of in-place tube welding, and application of these procedures virtually assures that the resultant in-place tube weld meets minimum engine requirements. These procedures, which govern cleaning, cutting, purging, and welding of tubes, are reflected in this section.

6-4. Cleaning procedures remove coatings and foreign substances from the surfaces that are to be cut and welded, preventing contamination and unsatisfactory fusion that can result from the presence of these materials. The abrasive and solvent specified for cleaning removes these coatings and foreign substances while leaving little or no residue harmful to the welding process.

6-5. Procedures controlling tube cutting specify the use of special cutters that prevent the generation of chips and minimize tube distortion caused by the cutting operation. In addition, the procedures control the location of cuts, keeping the mass that will be added by the weld sleeve adjacent to the tube supports.

6-6. Purging procedures satisfy two requirements essential for attaining quality welds. Purging removes active gases (mainly oxygen) from the area to be welded and replaces them with an inert gas. Removing the active gases prevents the gases from combining with the molten metal during welding and forming oxides and other contaminating residue. In addition, positive purge of the weldments supports the molten metal to attain a reasonably flat weld profile and is accomplished by providing a precisely controlled low differential pressure across the weldments during welding. The capability to accomplish the precise low differential pressure is provided by the use of specialized purge equipment developed for this purpose.

6-7. Since, as previously noted, in-place tube welds cannot be 100-percent inspected, welding procedures impose rigid requirements aimed at assuring that the in-place welds will meet minimum engine requirements. These include specifying the use of the specialized welding equipment, which was designed with reproducibility as the major criteria, and the fabrication of two successive test specimens, both of which meet optimum weld requirements, before welds on engine components are permitted. Requiring two successive test specimens to meet optimum weld requirements verifies the repeatability of the welder and develops assurance that the engine weld will meet minimum quality requirements. Attainment of quality in-place tube welds demands careful application of the task procedures contained in this section. Sequential listing of these tasks is not to be interpreted as a required order of performance.

6-8. WELDING REQUIREMENTS.

6-9. Prior to and during performance of in-place tube welding, the following requirements must be met:

NOTE

A test specimen is defined as a single circumferential weld made on a tube and sleeve (or fitting) combination that meets the material and weld position requirements of this section.

a. Two successive acceptable test specimens must be made before performing welds on engine components. The test specimens must conform to the following:

(1) Comparable in size and wall thickness to engine components to be welded.

(2) Welded using same cable hookup (weld head and ground) that will be used on engine welds.

(3) Weld schedule utilized for first acceptable test specimen to be used to weld second *test specimen.*

(4) No more than one hour to elapse between welding of acceptable test specimens.

(5) Purged with purge gas exiting from, or downstream (related to purge flow) of, engine juncture or junctures to be welded.

(6) If purge flow path contains a restriction that limits purge flow to an area less than the area of a 1/8-inch-diameter circle, PRE FLOW timer must be set to maximum time.

b. When two successive acceptable test specimens have been obtained, welds may be performed within the next 8-hour period on engine components of the same or comparable size without making additional test specimens, provided:

(1) Weld schedule used to fabricate the two acceptable test specimens is not changed except as allowed by welding procedures.

(2) Length of welding cables (weld head or ground) is not changed.

(3) Welder is not turned off.

(4) No more than one hour elapses between welds.

(5) External portion of previous weld meets applicable quality requirements.

(6) Point of purge introduction to engine is not changed.

(7) All welds are in path of purge flow from point of purge introduction to engine juncture from which test specimens were purged.

(8) Purge flowrate is not manually changed during or between welds except as necessary between welds to readjust purge pressures.

(9) Weld head or weld head components are not changed or repaired.

WARNING

Operating the welder with the operator or any portion of the welder electrical or purge equipment wet can result in death or injury to personnel and damage to equipment.

c. Do not operate welder with operator or any part of welder electrical or purge equipment wet.

d. Unless a crack or concavity is apparent, subsequent weld cycles may be made to obtain an acceptable weld joint; however, once the weld joint has been leak tested and accepted (no leakage), subsequent weld cycles are not permitted. Position DC FWD REV switch on welding head speed control unit so rotation of weld head rotor for each subsequent weld cycle will be opposite that of the previous cycle.

e. If subsequent weld cycles do not produce an acceptable weld or if a weld joint should leak after an acceptable leak test, replace discrepant weld. If discrepant weld is on a weld sleeve, replace weld sleeve with an appropriate repair sleeve RD273-1029-XXXX. When repair sleeves are not available or where conditions do not permit their use (excessive gap or insufficient straight tube section), use a tube insert and 2 appropriate weld sleeves RD273-1023-XXXX. Make sure tube insert is of same material as original tube and is fabricated to same configuration.

f. When replacing instrumentation system tees 703096, pneumatic system tees 556120 may be substituted if the following conditions are met:

(1) Fewer weld joints are required.

(2) Tube clamping and clearance requirements of section I are met.

(3) It is not necessary to reroute the tubing.

(4) When the tee being replaced incorporates a plugged outlet, the tube to the plugged outlet must protrude 1-2 inches (1 inch preferred) on the replacement tee. (This dimension excludes the length added by the sleeve and plug). Subsequent cutting and plugging of this tube may be performed until the minimum insertion requirements cannot be met.

g. When performing any procedure in this section, observe safety precautions and contamination and damage prevention requirements in section I.

6-10. WELDING.

6-11. This paragraph provides procedures for accomplishing in-place tube welds using Automatic Inert Gas Arc Welder Set G3128 and Single Head Special Tool Kit G3127. Requirements of paragraph 6-8 must be observed in the performance of the tasks contained in or referenced by this paragraph.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. The following equipment and materials are required for this task:

(1) Automatic Inert Gas Arc Welding Set G3128

(2) Single Head Special Tool Kit G3127MD3

(3) Abrasive: silicon-carbide cloth or paper, 320 grit or finer

(4) Solvent: trichloroethylene (MIL-T-27602), trichloroethane (Federal Specification O-T-620), or cleaning compound (MIL-C-81302).

(5) Nylon cloth No. 7815 (Victor Gloves, Inc), or equivalent

(6) Nylon gloves No. 7862 (Victor Gloves, Inc), or equivalent

(7) Comparison sleeves 046911

(8) Helium conforming to requirements contained in section I

(9) Argon (MIL-A-18455)

(10) 230/460 ±5% vac, 3-phase, 60-cycle, 42 amperes at 230 vac and 21 amperes at 460 vac

b. Make sure welder and weld heads are prepared. (Refer to paragraphs 6-12 and 6-14.)

c. Start pre-weld purge of engine system to be welded. (Refer to paragraph 6-16.)

d. Start purge of weld head by turning HEAD PURGE REGULATOR to INCR until maximum flow is indicated on associated flowmeter or maximum differential pressure is indicated on differential gage, whichever occurs first.

e. If engine tubes to be welded have not been cut, cut them. (Refer to paragraph 6-19.)

f. Obtain tubing and sleeves or fittings, as necessary, for fabricating test specimens. Tubing and sleeves or fittings must be comparable to components to be welded on engine. To be comparable, tubing, sleeves, or fittings used for test specimens must comply with the following:

(1) If weld is a tube-to-sleeve weld, fabricate test specimens of a tube of same material, diameters and wall thickness and a sleeve with same part number as those to be welded on engine.

(2) If weld is a sleeve-to-plug weld, fabricate test specimens using a sleeve and plug with same part numbers as those to be welded on engine.

(3) If weld is a tube-to-fitting weld, fabricate test specimens with a tube of same material, diameter, and wall thickness as engine tube and a fitting having same part number as fitting to be welded. A weld sleeve may be substituted for fitting. If weld sleeve is substituted, obtain wall thickness of fitting and see figure 6-1 for acceptable weld sleeve substitute.

WARNING

The following procedure uses trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of the vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure uses cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area, since the vapors displace the oxygen in the air, resulting in suffocation.

g. Clean tube surfaces to be welded by rubbing with abrasive cloth or paper and then wiping with clean nylon cloth dampened with solvent.

To Weld Tube to Tube			
Tube Size (inch)	Use Weld Sleeve RD273-1023-	or Repair Sleeve RD273-1029-	And Schedule Number
1/4 x 0.028	0005	0002	2
1/4 x 0.035	0005	0002	4
1/4 x 0.049	0006	0003	6
5/16 x 0.065	1007		7
3/8 x 0.035	2005	1001	8/9
3/8 x 0.049	2006	1002	11
3/8 x 0.058	2006		12
3/8 x 0.065	2007	1003	13
1/2 x 0.035	3005	2001	14
1/2 x 0.049	3006 or 7006	2002	16
5/8 x 0.035	4005	3001	17
3/4 x 0.049	5006	4002	18
1 x 0.035	6005		19
1 x 0.049	6006	5001	20

To Weld Tube to Fitting			
Tube Size (inch)	To Fitting With Wall Thickness (inch)	For Test Specimen, Use Same Part Number Fitting or Weld Sleeve RD273-1023-	And Schedule Number
1/4 x 0.028	0.030	0004	1
1/4 x 0.028	0.033	0005	2
1/4 x 0.035	0.030	0004	3
1/4 x 0.035	0.033	0005	4
1/4 x 0.035	0.047	0006	5
1/4 x 0.049	0.047	0006	6
5/16 x 0.065	0.063	1007	7
3/8 x 0.035	0.037	2005	8/9
3/8 x 0.049	0.037	2005	10
3/8 x 0.049	0.047	2006	11
3/8 x 0.058	0.047	2006	12
3/8 x 0.065	0.063	2007	13
1/2 x 0.035	0.033	3005	14
1/2 x 0.035	0.047	3006 or 7006	15
1/2 x 0.049	0.047	3006 or 7006	16
5/8 x 0.035	0.033	4005	17
3/4 x 0.049	0.047	5006	18
1 x 0.035	0.033	6005	19
1 x 0.049	0.047	6006	20

Schedule Number	Pre Flow (min ±10%)	Post Flow (sec ±10%)	Weld Duration (sec +10%, -0%)	Rotor Speed (sec/rev +10°, -0°)	Fixture Delay (sec)	Sequence Stop (sec ±10%)	Starting Slope(b)		Tail Slope(b)		Purge Pressures		Weld Current (amperes)(b)
							Current	Time	Current	Time	Head Pressure (inch) of H_2O	Head-Tube Differential Pressure (inches of H_2O)	
1	1	30	16	14	5-6	15	1/2 to 3/4	7	1-1/2 to 2-1/2	8	1.9 to 2.0	1.7 to 2.0	32
2	1	30	16	14	6-7	15	1/2 to 3/4	7	1-1/2 to 2-1/2	8	1.9 to 2.0	1.7 to 2.0	34
3	1	30	16	14	6-7	15	1/2 to 3/4	7	1-1/2 to 2-1/2	8	1.9 to 2.0	1.7 to 2.0	35
4	1	30	16	14	8-9	15	3/4 to 1	7	1-1/2 to 2-1/2	8	1.9 to 2.0	1.7 to 2.0	36
5	1	30	16	14	8-9	15	3/4 to 1	7	1-1/2 to 2-1/2	8	1.9 to 2.0	1.7 to 2.0	46
6	1	30	16	14	8-9	15	1 to 1-1/4	7	2-1/2 to 3-1/2	8	1.9 to 2.0	1.7 to 2.0	50
7	1	30	19	17	8-9	15	1-1/2 to 1-3/4	7	2-1/2 to 3-1/2	8	1.9 to 2.0	1.2 to 1.8	70
8	2	30	23	21	8-9	15	3/4 to 1	7	1-1/2 to 2-1/2	8	1.9 to 2.0	1.0 to 1.6	40
9(a)	2	30	23	21	3-4	15	1/2 to 3/4	7	1-1/2 to 2-1/2	8	1.9 to 2.0	0.0 to 0.6	32
10	2	30	23	21	9-10	15	1 to 1-1/4	7	2-1/2 to 3-1/2	8	1.9 to 2.0	0.0 to 0.6	50
11	2	30	23	21	9-10	15	1 to 1-1/4	7	2-1/2 to 3-1/2	8	1.9 to 2.0	0.0 to 0.6	54
12	2	30	23	21	8-9	15	1-1/4 to 1-1/2	7	2-1/2 to 3-1/2	8	1.9 to 2.0	0.0 to 0.6	64
13	2	30	23	21	8-9	15	1-1/4 to 1-1/2	7	2-1/2 to 3-1/2	8	1.9 to 2.0	0.0 to 0.6	70
14	3	30	30	28	6-7	15	1/2 to 3/4	7	1-1/2 to 2-1/2	8	1.9 to 2.0	0.0 to 0.6	42
15	3	30	30	28	8-9	15	1 to 1-1/4	7	1-1/2 to 2-1/2	8	1.9 to 2.0	0.0 to 0.6	46
16	3	30	30	28	8-9	15	1 to 1-1/4	7	2-1/2 to 3-1/2	8	1.9 to 2.0	0.0 to 0.6	56
17	3	30	36	34	8-9	15	3/4 to 1	7	1-1/2 to 2-1/2	8	1.9 to 2.0	-0.3 to 0.3	46
18	4	30	44	42	8-9	15	1-1/4 to 1-1/2	7	2-1/2 to 3-1/2	8	1.9 to 2.0	-0.3 to 0.3	66
19	6	30	57	55	8-9	15	3/4 to 1	7	1-1/2 to 2-1/2	8	1.9 to 2.0	-0.3 to 0.3	46
20	6	30	57	55	8-9	15	1-1/4 to 1-1/2	7	2-1/2 to 3-1/2	8	1.9 to 2.0	-0.3 to 0.3	66

(a) Fillet welds only

(b) Values may be varied to obtain acceptable test specimen.

J2-3-1-69

Figure 6-1. Welding Schedule

h. Just before assembling joint to be welded, wearing clean, lint-free nylon gloves, remove repair sleeve, weld sleeve, tee, or fitting from package. Using comparison sleeves, visually inspect outside surfaces for the following:

(1) Dull, grey finish (see dull comparison sleeve) is not acceptable; reject sleeve, tee, or fitting, as applicable.

(2) Shiny, silver finish (see shiny comparison sleeve) is acceptable.

(3) Burs or foreign matter are not acceptable on interior and exterior surfaces.

i. If acceptable sleeve, tee, or fitting is accidentally contaminated during inspection, clean before using. Clean as outlined in step g, or by vapor immersion spray degreasing.

j. Assemble components to be welded, connecting them to tube from which engine purge gas is exiting. Use appropriate tube position tool 9027438 to position sleeve.

k. Remove cap (if installed) from tube position tool.

l. Adjust weld head rotor speed. (Refer to paragraph 6-21.)

m. If tube to be welded is vertical, omit this step; otherwise, position weld head on tube so that initial movement of electrode is upward and starting position is as follows: (Pressing FIXTURE JOG button on remote control box will rotate electrode.)

(1) On 3/8-inch-diameter tube (or smaller), between 7 and 12 o'clock if electrode is rotating clockwise or between 12 and 5 o'clock if electrode is rotating counterclockwise.

(2) On 1/2-inch-diameter tube (or larger), between 8 and 9 o'clock if electrode is rotating clockwise or between 3 and 4 o'clock if electrode is rotating counterclockwise.

n. Install weld head on tube, positioning head so that electrode (centerline of weld) meets requirements of dimension B, figure 6-2.

o. Attach ground clamps to tube. Attach a ground clamp to tube on each side of weld head. In the event that clamps cannot be attached on each side of weld head, attach both ground clamps to one side and make weld on side of sleeve adjacent to clamps.

WARNING

The current cable connecting the weld head to the weld set power supply must not be grounded (short circuited) since this can injure personnel or damage equipment.

CAUTION

Failure to isolate the welding cables can cause loss of high-frequency voltages resulting in failure to establish an arc.

oA. Make sure welding cables are a minimum of 6 inches apart, except at welding unit and weld head, and are isolated from conductive surfaces. Isolate welding cables from conductive surfaces by either suspending them, using a nonconductor, or laying them on a nonconductor.

CAUTION

Clearances of less than 1/4-inch between weld current carrying, or potential weld current carrying components of the weld head and ground can damage the weld head and/or the grounded component.

- Laying or securing any material to the weld head that impedes its ability to dissipate heat can result in damage to the weld head.

oB. Make sure a minimum 1/4-inch gap exists between any of the following parts of the weld head and an electrically conductive path to ground. If gap is less than 1/4-inch, either reposition weld head to obtain required clearance (repeat steps m and n) or place insulating material between affected part on weld head and conductive path. Any good insulator such as pressure-sensitive tape RB0195-002 (Rocketdyne), rubber, asbestos, etc, may be used. Do not secure or lay insulator on weld head.

(1) Screws that secure covers to weld head.

(2) Spring and brush (see figure 6-9D).

p. Install cap on tube position tool and adjust head-tube differential pressure. (Refer to paragraph 6-23.)

q. Set controls listed in figure 6-1 to values noted for combination to be welded. Disregard ROTOR SPEED, PURGE PRESSURES, and WELD CURRENT. ROTOR SPEED and PURGE PRESSURES have been previously set, and WELD CURRENT will be set during fixture delay phase of the weld cycle. If engine system contains an orifice that restricts flow of purge gas to an area less than a 0.125-inch-diameter circle, set PRE FLOW timer to maximum rather than value required by figure 6-1.

r. Make sure the following controls on welder are positioned as noted:

(1) WATER PUMP to OFF

(2) ADJUSTABLE STARTING SPIKE to 10

(3) ARC CONTROL to INERT ARC

(4) CURRENT CONTROL to 100 amperes

(5) Polarity lever to STRAIGHT POLARITY

(6) High-frequency unit ON-OFF switch to ON

(7) H.F. INTENSITY to 3 o' clock position

(8) AMMETER SELECTOR SWITCH to 100

s. Make sure the following controls on programmer are positioned as noted:

(1) HI. FREQUENCY to START

(2) STARTING SLOPE to SLOPE UP

(3) START & TAIL to ON

(4) START & TAIL SLOPE -- TAIL SLOPE ONLY to START & TAIL SLOPE

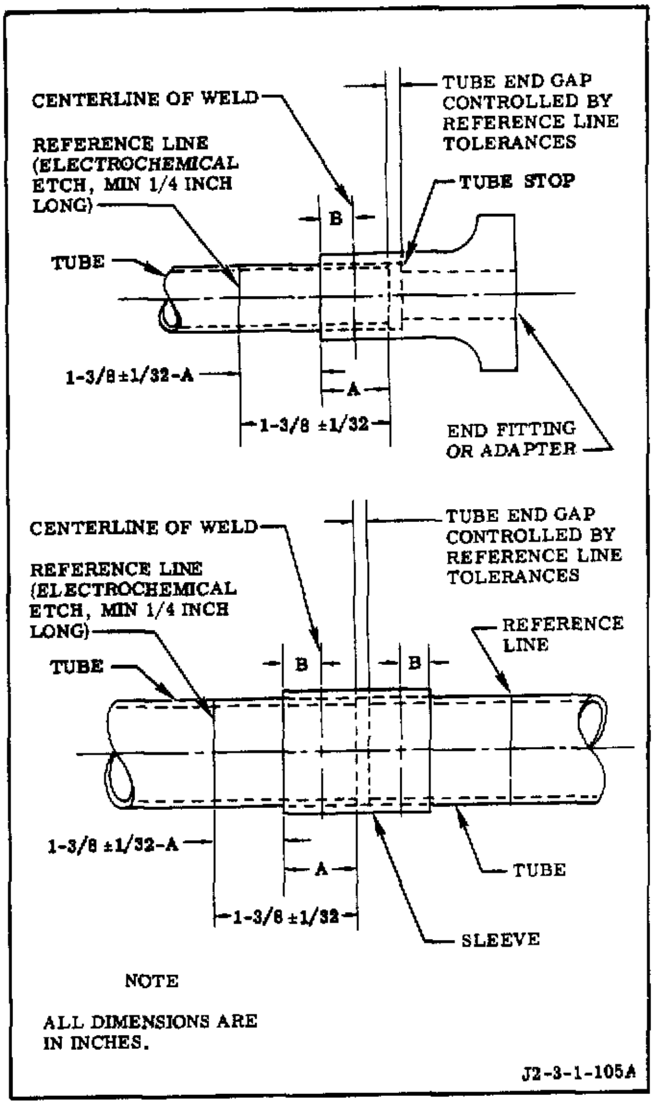
(5) TAIL SLOPE to SLOPE DOWN

(6) Low current to OUT

(7) LOW CURRENT RHEOSTAT to zero

(8) FIXTURE TIMING to OFF

t. Evaluate whether system can be considered adequately purged before proceeding to next step. Refer to paragraph 6-16 for means of determining adequacy of engine purge. One-half hour is nominally required from initial application of purge flow to adequately purge the weld head purge supply system and weld head. If purge is considered inadequate, remove cap from tube position tool, allow purge gas to flow until purge is considered adequate, and then reinstall cap on tube position tool.



Tube OD (inch)	1/4 to 1/2	5/8 to 1
-A- Sleeve Joint (+0, -1/32 inch)	3/8	1/2
-A- Minimum (inch) End Fitting	3/8	1/2
-A- Maximum (inch) End Fitting and Adapter Without Tube Stop Only	1/2	5/8
-B- Weld Location (+3/32, -1/16 inch)	5/32	7/32

Figure 6-2. In-Place Tube Welding Tolerances

u. Determine initial weld current (figure 6-1), and set ARC CONTROL on remote control box to equivalent value ±2 increments. This will adjust the weld current to the approximate value obtained from figure 6-1.

v. Verify that purge pressures meet requirements of figure 6-1. Readjust if necessary.

WARNING

With the actuation of the SEQ. START button in the next step, dangerous voltage and current are applied to the welding cable. Contact with the cable can result in serious injury or death.

w. Make sure personnel are clear of welding cable; then start weld cycle by momentarily pressing SEQ. START button on remote control box. Welding starts when PRE FLOW timer times out, is automatically controlled through the weld cycle, and is complete when POST FLOW timer times out. (See figure 6-3 for sequence of weld operations.) During FIXTURE DELAY (which commences with completion of PRE FLOW), set desired weld current by rotating ARC CONTROL on remote control box (and if necessary CURRENT CONTROL knob on welder).

x. When welded tube is comfortable to touch, remove weld head.

y. Cut welded tube lengthwise and inspect weld. Weld must meet requirements of figure 6-4, and weld area must be free of internal residue. If weld meets requirements, proceed to next step. If weld does not meet requirements, see figure 6-5, which is a listing of weld problems and one or more of the most probable causes. If weld parameters require changing to correct a weld defect, change parameters within limits given in figure 6-1.

z. Make sure components to be welded for additional test specimen are clean and acceptable (steps g through i).

aa. Assemble components to be welded, connecting them to tube from which engine purge gas is exiting. Use appropriate tube position tool 9027438.

ab. Remove cap from tube position tool, and allow purge gas to flow through tube for same period of time for which PRE FLOW timer is set.

ac. If tube to be welded is vertical, omit this step; otherwise, position weld head on tube so that initial movement of electrode is upward and starting position is as follows: (Pressing FIXTURE JOG button on remote control box will rotate electrode.)

(1) On 3/8-inch-diameter tube (or smaller), between 7 and 12 o'clock if electrode is rotating clockwise or between 12 and 5 o'clock if electrode is rotating counterclockwise.

(2) On 1/2-inch-diameter tube (or larger), between 8 and 9 o'clock if electrode is rotating clockwise or between 3 and 4 o'clock if electrode is rotating counterclockwise.

ad. Install weld head on tube, positioning head so that electrode (centerline of weld) meets requirements of dimension B, figure 6-2.

ae. Attach ground clamps to tube. Attach a ground clamp to tube on each side of weld head. If clamps cannot be attached on each side of weld head, attach both ground clamps to one side and make weld on side of sleeve adjacent to clamps.

CAUTION

Clearances of less than 1/4-inch between weld current carrying, or potential weld current carrying components of the weld head and ground can damage the weld head and/or the grounded component.

- Laying or securing any material to the weld head that impedes its ability to dissipate heat can result in damage to the weld head.

aeA. Make sure a minimum 1/4-inch gap exists between any of the following parts of the weld head and an electrically conductive path to ground. If gap is less than 1/4-inch, either reposition weld head to obtain required clearance (repeat steps ac and ad) or place insulating material between affected part on weld head and conductive path. Any good insulator such as pressure-sensitive tape RB0195-002 (Rocketdyne), rubber, asbestos, etc, may be used. Do not secure or lay insulator on weld head.

(1) Screws that secure covers to weld head.

(2) Spring and brush (see figure 6-9D).

af. If previous weld sample exhibited contamination, allow additional purge time before proceeding.

ag. Install cap on tube position tool.

ah. Make sure purge pressures (figure 6-1) are properly set. Readjust as necessary.

WARNING

With the actuation of the SEQ. START button in the next step, dangerous voltage and current are applied to the welding cable. Contact with the cable can result in serious injury or death.

ai. Make sure personnel are clear of welding cable; then start weld cycle by momentarily pressing SEQ. START button on remote control box. Welding starts when PRE FLOW timer times out, is automatically controlled through the weld cycle, and is complete when POST FLOW timer times out. (See figure 6-3 for sequence of weld operations.) During FIXTURE DELAY and if an acceptable test specimen has not been obtained, weld current may be adjusted as outlined in step w. However, if test specimen being welded is intended to be second successive acceptable test specimen, changing weld current is not permitted.

aj. When welded tube is comfortable to touch, remove weld head.

ak. Cut welded tube lengthwise and inspect weld. Weld must meet requirements of figure 6-4, and weld area must be free of internal residue. If weld meets requirements and is the second successive acceptable test specimen, proceed to next step. If weld does not meet requirements, see figure 6-5, which is a listing of weld problems and one or more of the most probable causes. If weld parameters require changing to correct a weld defect, change parameters within limits given in figure 6-1.

al. When two successive acceptable test specimens have been made, as many welds as necessary may be made on the engine providing the applicable requirements of paragraph 6-8 and steps am through au are observed.

am. Make sure components to be welded are clean and acceptable (steps g through i), and assemble components. Comply with requirements of figure 6-2.

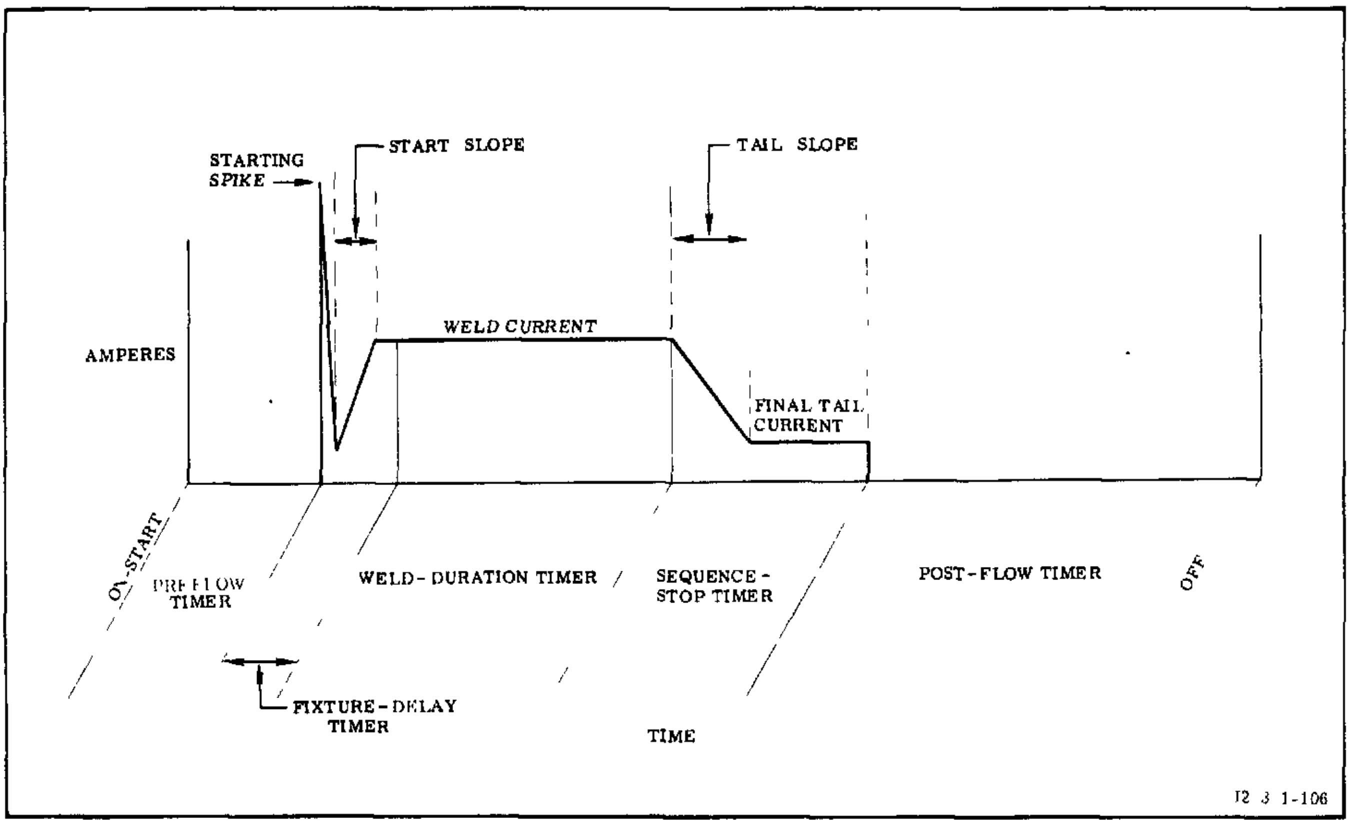


Figure 6-3. Automatic Welder Sequence of Operation

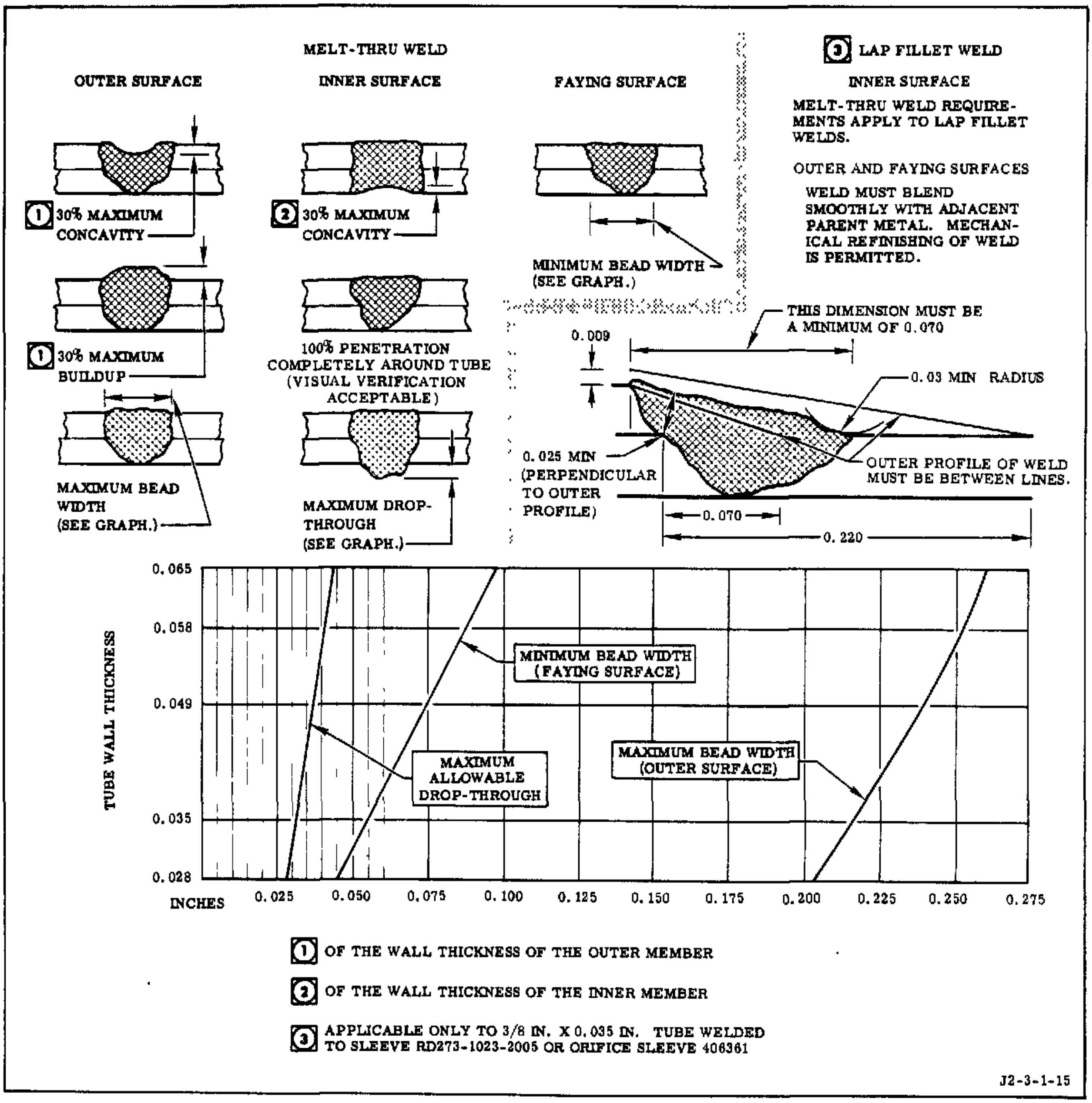


Figure 6-4. In-Place Melt-Thru and Fillet Weld Quality Requirements

CAUTION

The weld head side plate covers may produce particles of boron nitride during initial thermal shock. Loose material must be removed after sample welds are made and before welding is accomplished on engine or contamination of the engine may result.

amA. Inspect weld head side plate covers for any loose material after sample welds have been completed. Remove any loose material from weld head side plates by rubbing with clean nylon cloth.

Problem	Most Probable Cause
1. No arc	High-frequency switch off
2. High-frequency arc but no weld current arc	(a) STARTING SLOPE CURRENT too high (b) Insufficient weld-head purge
3. Arc lost after weld current arc initiated	(a) SEQ. STOP switch OFF (b) START & TAIL switch positioned to OFF (c) Side plates wrong size
4. Tungsten tip damaged	(a) Setscrew not tight. (On 2-piece rotor, torque setscrew to one in-lb max; on hinged rotor, torque setscrew to 3.0 to 3.5 in-lb.) (b) Mishandled
5. Incomplete revolution of tungsten	(a) Weld speed too slow (b) WELD DURATION incorrectly set (c) Rotor binding check for clearance
6. Consistent excess concavity or drop-through	(a) Weld current too high (b) Insufficient tube purge (c) Incorrect HEAD/TUBE differential pressure (d) Parts being welded are dirty
7. Insufficient penetration	(a) Weld current too low (b) Weld speed too fast (c) Parts abraded with aluminum oxide cloth or paper
8. Unequal penetration	(a) Side plates damaged or wrong size (b) Tungsten improperly positioned at start of weld.
9. Crater at end of weld	Incorrect TAIL SLOPE adjustment
10. Bead width (outer surface) too wide	(a) Included angle of tungsten tip too small (must be 80° to 90°) (b) Excessive gap between tungsten tip and weld sleeve. (Refer to paragraph 6-14.)
11. Bead width (faying surface) too narrow	(a) Included angle of tungsten tip too small (must be 80° to 90°) (b) Tungsten tip gap incorrect. (Refer to paragraph 6-14.)
12. Inner surface contaminated	(a) Insufficient pre-weld purge (b) Dirty parts
13. Outer surface contaminated	(a) Insufficient head purge (b) Dirty parts
14. Waver in weld trace	Excessive purge flow
15. Side plate cracked	(a) Weld head warped (b) Attaching screws over-torqued (maximum one in-lb)

Figure 6-5. Probable Causes of Weld Defects

an. If tube to be welded is vertical, omit this step; otherwise, position weld head on tube so that initial movement of electrode is upward and starting position is as follows: (Pressing FIXTURE JOG button on remote control box will rotate electrode.)

(1) On 3/8-inch diameter tube (or smaller), between 7 and 12 o' clock if electrode is rotating clockwise or between 12 and 5 o' clock if electrode is rotating counterclockwise.

(2) On 1/2-inch-diameter tube (or larger), between 8 and 9 o' clock if electrode is rotating clockwise or between 3 and 4 o' clock if electrode is rotating counterclockwise.

ao. Install weld head on tube, positioning head so that electrode (centerline of weld) meets requirements of dimension B, figure 6-2.

CAUTION

Flowing welding current through an engine component can damage the component.

ap. Attach ground clamps, one on each side of weld head, within 12 inches of weld head. Ground clamps are to be attached as close to the weld head as practical, and in no case is there to be an engine component in the most direct current path between the weld head and ground clamps. Where ground clamps cannot be attached on each side of weld head without including an engine component in the most direct current path, attach both ground clamps on one side of weld head; then make first weld on side of sleeve adjacent to clamps.

CAUTION

Clearances of less than 1/4-inch between weld current carrying, or potential weld current carrying components of the weld head and ground can damage the weld head and/or the grounded component.

- Laying or securing any material to the weld head that impedes its ability to dissipate heat can result in damage to the weld head.

apA. Make sure a minimum 1/4-inch gap exists between any of the following parts of the weld head and an electrically conductive path to ground. If gap is less than 1/4-inch, either reposition weld head to obtain required clearance (repeat steps an and ao) or place insulating material between affected part on weld head and conductive path. Any good insulator such as pressure-sensitive tape RB0195-002 (Rocketdyne), rubber, asbestos, etc, may be used. Do not secure or lay insulator on weld head.

(1) Screws that secure covers to weld head.

(2) Spring and brush (see figure 6-9D).

WARNING

The current cable connecting the weld head to the weld set power supply must not be grounded (short circuited) since this can injure personnel or damage equipment.

CAUTION

Failure to isolate the welding cables can cause loss of high-frequency voltages resulting in failure to establish an arc.

apB. Make sure that welding cables are a minimum of 6 inches apart, except at welding unit and weld head, and are isolated from conductive surfaces. Isolate welding cables from conductive surfaces by either suspending them, using a nonconductor, or laying them on a nonconductor.

aq. If engine system being welded can be opened downstream of weld, open system and permit purge gas to flow for an equivalent or longer period of time than shown in weld schedule (figure 6-1) for preflow; then close system. If system being welded cannot be opened downstream, use 10 minutes for preflow instead of values in weld schedule.

NOTE

Additional flow purges the downstream side of the weld joint. Where flow conditions cannot be obtained, additional preflow time must be allowed to dilute the contaminating gases on the downstream side to an acceptable level.

ar. Make sure PURGE PRESSURE (figure 6-1) is properly set before each weld. Adjust if necessary.

WARNING

With the actuation of the SEQ. START button in the next step, dangerous voltage and current are applied to the welding cable. Contact with the cable can result in serious injury or death.

as. Make sure personnel are clear of welding cable; then start weld cycle by momentarily pressing SEQ. START button on remote control box. Welding starts when PRE FLOW timer times out, is automatically controlled through the weld cycle, and is complete when POST FLOW timer times out. (See figure 6-3 for sequence of weld operations.)

at. When welded tube is comfortable to touch, remove weld head.

au. Inspect weld. Visible portions of weld must meet applicable requirements of figure 6-4.

av. Wrap all currently welded joints with a minimum of 1-1/2 wraps of clean polyethylene film (0.002-inch minimum thickness) extending a minimum of 1/4 inch beyond sleeve or fitting. Seal ends and seam of film with pressure-sensitive tape RB0195-002 (Rocketdyne). Film must remain in place until joint is successfully leak tested. Care must be taken when removing protective film to prevent scratching the tubing.

NOTE

Until successfully leak tested, a welded joint is considered an open port and, therefore, requires protection from contamination.

aw. Reinstall line support blocks and/or clamps previously loosened or removed for access to weld.

6-12. PREPARING WELDER.

6-13. Preparing the welder consists of verifying that the welder is wired correctly for facility power available, connecting the welder to the facility power, and installing extension cables and purge hoses that may be necessary to permit welding remotely from the welder.

WARNING

Automatic Inert Gas Arc Welding Set G3128 must not be operated in the rain or with any part of the welding equipment in water, since the equipment can short-circuit, resulting in death or serious injury to personnel and damage to equipment.

NOTE

If the weld head is subjected to air drafts or windy conditions during operation, the weld head may be covered or shielded to prevent dissipation of heat and shielding gas.

a. Locate welding set adjacent to a source of 230- or 460-volt power, a minimum of 6 inches from any wall or obstruction to allow air circulation through welding set, and within 100 feet of component to be welded. If possible, position welder within 25 feet of component to be welded and engine port through which purge gas is to be applied. Positioning the welder within 25 feet will preclude removing the purge panel from the welder and the use of extension welding cables and purge hoses. Keep welding set out of wet areas.

CAUTION

The high-frequency unit is heavy and must be handled with care to prevent damage.

b. Make sure welder is wired for voltage compatible to facility supply. To ascertain welder voltage, remove high-frequency unit and front panel and check terminal block wiring configuration. See figure 6-6 for arrangement of jumper links for 230 or 460 vac. Reinstall panel and high-frequency unit.

c. If welder is positioned more than 25 feet from component to be welded, connect extensions (welding power cable, weld head motor cable, and welding ground cable) necessary to permit placement of weld head and ground clamp in weld area. (See figure 6-7.)

CAUTION

The purge panel is calibrated for tube purge and press hose assembly 9027447-11 and head purge and press hose assembly 9027448 between the panel and areas to be purged. Adding extensions to these hoses invalidates panel calibration.

d. If welder is more than 25 feet from component to be welded or from port through which internal purge is to be applied (paragraph 6-16), remove purge panel from welder and position panel within 25 feet of each point. Connect extension hoses, as necessary, between panel and source of purge gas supply. (See figure 6-7.) Do not add extensions between panel and areas to be purged.

NOTE

In confined areas where the use of the purge panel stabilizers would create a hazard, the stabilizers may remain stowed or temporarily removed, providing other means are taken to prevent the panel from tipping over.

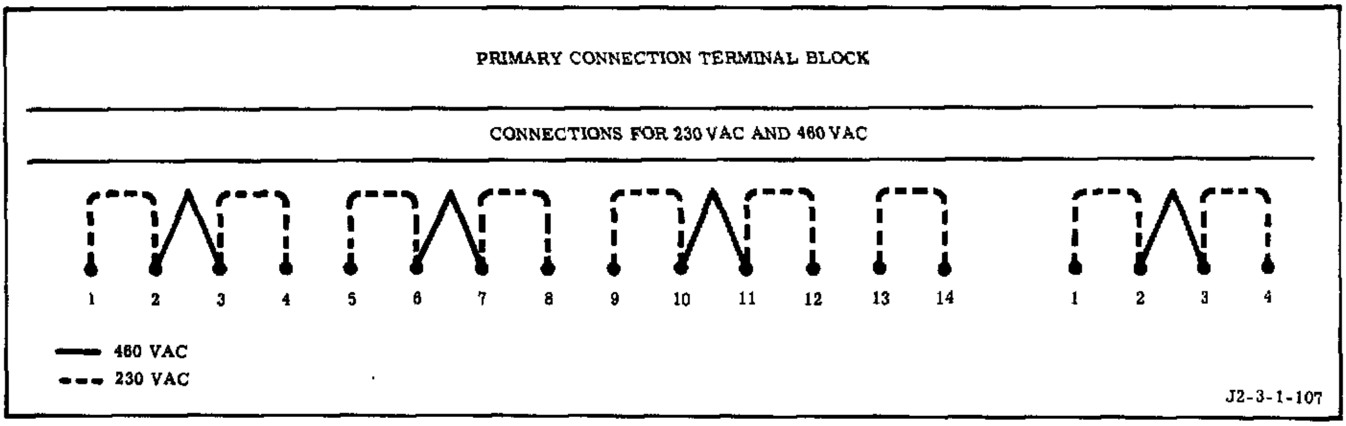


Figure 6-6. Welding Set Power Supply Terminal Connection Block

To Extend	Use	Remarks	Torque Couplers to
Remote control	Cables TWH200-18		Handtight
Weld head Motor control	Cables TWH200-21	Install between weld head and speed control.	Handtight
Weld head current cable	Cables 65396		Handtight
	Cable 65400	If installed, remove terminal block TWH200-4 from ELECTRODE terminal and replace with cable 65400.	Torque nut that secures cable 65400 to 100-130 in-lb
Weld ground clamp	Cables TWH200-27		Not applicable
Purge panel	Hoses 9027450 Couplers 9027280	Install between panel and source of purge gases.	135-185 in-lb

Figure 6-7. Extensions for Automatic Inert Gas Arc Welding Set G3128

e. Connect remote control box using extension cables if desired. (See figure 6-7.)

f. Make sure an adequate supply of argon is available. To evaluate argon requirements, estimate a minimum of 8 cubic feet for each hour of purge, with an additional 1/2 hour to prepurge panel and hoses. Allow for continuous purging of weld head between welds.

g. Make sure a source of helium is connected to purge panel. Helium required cannot be accurately estimated, since volume, configuration of system being purged, contamination level of existing gases in engine, and velocity of purge introduction all affect time required for preweld purge.

gA. Make sure quick-disconnect nipple 5104-04X-N7 and coupler 5404-04X-N7 are installed on head purge and press hose. If not installed, obtain them from the single head special tool kit and install them.

NOTE

Orientation of nipple and coupler to HEAD PRESS and HEAD PURGE ports is optional.

h. Attach welder external ground cable to a suitable facility ground.

i. Make sure facility power to be used for welder is deenergized and MAIN CIRCUIT BREAKER on welder is in OFF position; then connect welder to facility power.

6-14. PREPARING WELD HEADS.

6-15. Preparing a weld head for use consists of proper selection and installation of electrode and covers. To determine required electrode, electrode adjustment gages, and covers obtain size of tube and part number of sleeve to be welded, and dependent upon weld head being prepared, see appropriate figure 6-9A or 6-9B.

WARNING

Ground support equipment used during this task must be operated by authorized personnel trained in the use of the equipment.

a. Make sure one end of electrode to be used is configured as shown in figure 6-9C. Electrode may be ground to meet this requirement.

Figures 6-8 and 6-9 deleted.

Tube Size (in. OD)	Weld Sleeve RD273-1023 Dash No.	Repair Sleeve RD273-1029 Dash No.	Top Inner Cover 9022908 Dash No.	Bottom Inner Cover 9022909 Dash No.	Top Outer Cover 9022919 Dash No.	Bottom Outer Cover 9022920 Dash No.	Electrode 9022906[b] Dash No.	Female Electrode Adjustment Gage 9027427 and Male Electrode Adjustment Gage 9027431[a]
1/4	-0004		-113	-113	-113	-113	-5	(-0004)
	-0005	-0002	-115	-115	-115	-115	-5	-5 (-0005)
	-0006	-0003	-117	-117	-117	-117	-5	-7 (-0006)
3/8	-2004		-153	-153	-153	-153	-3	None
	-2005	-1001	-155	-155	-155	-155	-3	-13 (-2005)
	-2006	-1002	-157	-157	-157	-157	-3	-15 (-2006)
1/2	-3005	-2001	-175	-175	-175	-175	-3	-33 (-3005)
	-3006	-2001	-177	-177	-177	-177	-3	-35 (-3006)

(a) Male electrode adjustment gages are marked with sleeve dash number
(b) Alternate, bulk electrode MRP-63-06-79

Figure 6-9A. Interrelation of Covers, Electrodes, and Gages to Tube Size and Sleeve--Small Head (Single-Head Special Tool Kits G3127 Incorporating MD3 Change)

Tube Size (in. OD)	Weld Sleeve RD273-1023 Dash No.	Repair Sleeve RD273-1029 Dash No.	Top Inner Cover 9022958 Dash No.	Bottom Inner Cover 9022959 Dash No.	Top Outer Cover 9022961 Dash No.	Bottom Outer Cover 9022962 Dash No.	Electrode 9022956[b] Dash No.	Female Electrode Adjustment Gage 9027427-11 and Male Electrode Adjustment Gage 9027431[a]
1/2	-3006 or -7006	-2002	-117	-117	-117	-117	-7	-19 (-3006)
5/8	-4005	-3001	-137	-137	-137	-137	-5	-23 (-4005)
3/4	-5006	-4002	-159	-159	-159	-159	-5	-25 (-5006)
1	-6006	-5001	-183	-183	-183	-183	-3	-29 (-6006)

(a) Male electrode adjustment gages are marked with sleeve dash number
(b) Alternate, bulk electrode MRP-63-06-70

Figure 6-9B. Interrelation of Covers, Electrodes, and Gages to Tube Size and Sleeve--Large Head (Single Head Special Tool Kits G3127 Incorporating MD3 Change)

Section VI

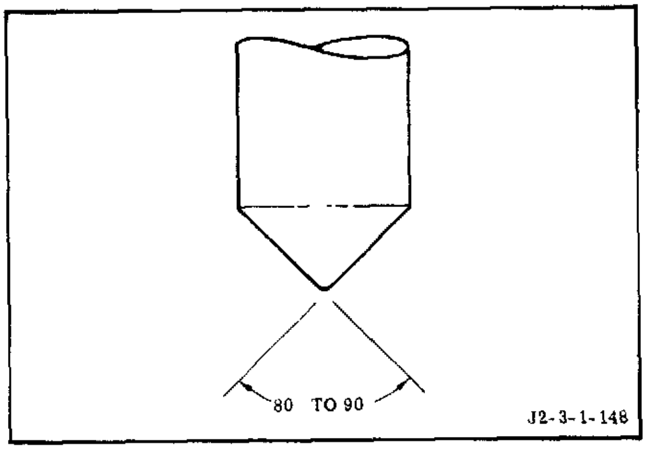


Figure 6-9C. Electrode Tip Configuration

b. Obtain applicable female electrode adjustment gage 9027427 or 9027427-11 with a male electrode adjustment gage 9027431 marked with same dash number as dash number of weld sleeve.

c. Place rotor with gear side down into female electrode adjustment gage and aline electrode bore of rotor with notch on outer periphery of gage.

d. Insert male electrode adjustment gage into female gage.

e. Insert electrode into rotor (with 80-90 degree tip toward male gage) and using rod of equal or smaller diameter push electrode against male gage. If alternate electrode is being used, install alternate electrode as follows:

(1) Insert electrode into rotor (with 80-90 degree tip toward male gage) until electrode tip is approximately 1/16 inch from male gage.

(2) Torque rotor setscrew to 1-2 in-lb.

(3) Remove rotor from electrode adjustment gages, install electrode break-off tool 9027432 (small-diameter electrode) or 9027433 (large-diameter electrode) over electrode until break-off tool touches outside diameter of rotor; then break off electrode.

(4) Reinstall rotor in electrode adjustment gages making sure electrode is alined with notch on outer periphery of female gage.

CAUTION

The electrode must not extend beyond the periphery of the rotor, since damage to the head assembly may result.

(5) Loosen rotor setscrew and using rod of equal or smaller diameter push electrode against male gage, making sure electrode does not extend beyond outer periphery of rotor.

f. Torque rotor setscrew to 3.0 to 3.5 in-lb.

g through k. (Deleted)

l. Install rotor in head, making sure geared portion of rotor engages drive gear.

lA. Make sure purge hole is unobstructed; then install top housing.

lB. Make sure a minimum of 0.015 inch exists between brush head and bottom housing. See figure 6-9D.

NOTE

Less than 0.015-inch gap between brush head and bottom housing can result in insufficient brush pressure against rotor, causing possible arcing.

m. Install covers, torquing screws to 0.50 ±0.01 in-lb. If it is suspected that covers have absorbed moisture, dry them before installation by subjecting them to an elevated temperature (such as an oven) until they are dry.

n. (Deleted)

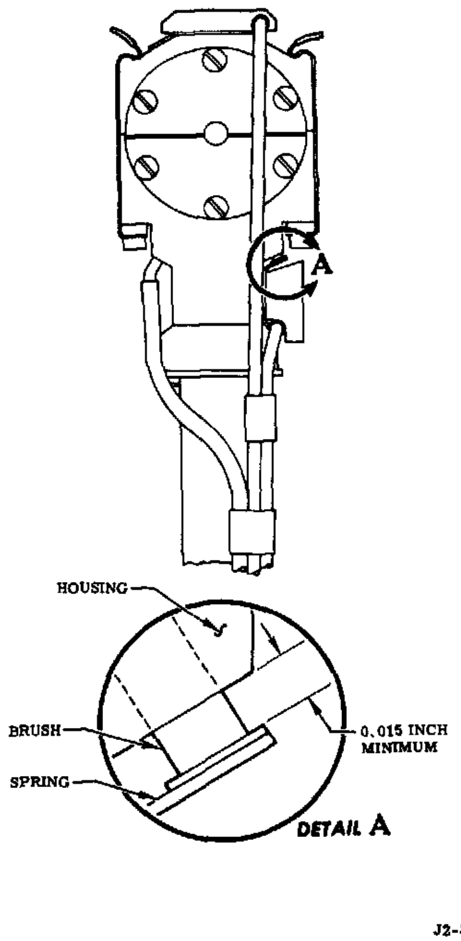


Figure 6-9D. Brush Head to Housing Gap (Rotor Installed)

o. Connect welding power cable, motor control cable, and head purge and pressure hose to weld head.

6-16. PRE-WELD AND WELDING PURGE REQUIREMENTS.

6-17. Obtaining quality in-place tube welds depends to a large degree on adequate pre-weld purge and weld purge pressures. The pre-weld purge establishes an inert atmosphere within the tube that prevents formation of contaminating residue during welding. To be sure the pre-weld purge is adequate, gases tapped from an engine junction to be welded are used to purge test specimens. The pre-weld purge is satisfactory when test specimens free of internal contamination are obtained. Weld purge pressures maintain the inert atmosphere during the welding process. Maintaining the inert atmosphere at a low differential pressure to the weld head purge, provides a continuous protection against contamination and supports the molten metal, resulting in a reasonable flat weld profile. When welding plugs 704386, deviations to the noted pre-weld purge and test specimen(s) requirements are permitted. (Refer to paragraph 6-18 for information on permissible deviation.) The following requirements must be observed in the performance of pre-weld purge and weld purge pressures:

a. Helium conforming to requirements contained in section I must be used for purging engine systems.

b. Determine engine port through which purge gas can be introduced to purge tube or tubes to be welded. As an aid in determining port for purge introduction, see figure 6-10. Users must familiarize themselves with sheet 1 of figure 6-10.

NOTE

The length of pre-weld purge time cannot be accurately estimated since volume, configuration of system being purged, contamination level of existing gases in engine, and velocity of purge introduction all affect purge effectiveness. However, in large systems containing a large percentage of contaminating gases, ten volume changes are usually required.

c. Attach G3128 purge panel or an alternate high-volume purge source to selected engine port. An alternate high-volume purge source can substantially reduce length of pre-weld purge time required in systems whose volume exceeds 1,000 cubic inches.

GENERAL

This figure contains internal purge data for in-place tube welding. The data is presented in a series of schematics, each of which illustrates the flow paths of the purge media when introduced at specific engine ports. The schematics also provide installation data for adapters used to adapt the engine port for purge introduction, reassembly data for the port, internal volumes, installation data for closures that may be required to develop weld purge pressures, and other pertinent data.

At present, this information is incomplete in that the schematics do not provide data for all engine tubes on which in-place welding may be performed.

HOW TO USE

To determine point of purge introduction and available purge adapter, locate area in which weld is to be performed on Index (sheet 2). If weld is on an instrumentation tube, locate associated tap code in Instrumentation Tap Index. Note associated circled numbers. The numbers identify sheets of this figure which contain the desired purge data.

The point of purge introduction is identified by the heavily bordered box on the schematic. This box contains the part number of the adapter to be installed, torque values for installing the adapter and reassembling the engine port, and other pertinent data.

The required purge volume is noted in the first volume symbol found, starting from weld area to point of purge introduction. See legend on sheet for example of symbol that contains purge volume. If no volume is noted, the volume is less than 150 cubic inches. Volumes are provided solely as an aid in evaluating potential purge time.

Closures for blocking potential sources of purge leakage are noted on the schematics. This data is for information only. The need to install any or all of these closures (or equivalents) is dependent upon the ability to develop weld purge pressure. Weld purge pressure is developed when the required HEAD/TUBE DIFFERENTIAL PRESSURE is obtained within the capacity of the TUBE FLOW flowmeter. (Noted instruments are found on the Automatic Inert Gas Arc Welding Set G3128 purge panel.) If weld purge pressure cannot be attained within the capacity of the flowmeter, block leakage until weld purge pressure is attained, installing first those closures that are in the path of direct purge application. To determine the path of direct purge application, see schematic legends. Closure selections that result in minimum engine disassembly are desired.

NOTE

An equivalent to any closure noted on the schematics is any device that will contain the low weld purge pressure while maintaining the integrity of the affected system.

INSTRUMENTATION TAP INDEX

Code	Sheet No.	Code	Sheet No.	Code	Sheet No.	Code	Sheet No.
GF4	9 12	GO5	9 12	PF3	11	PO8	8 10
GG1	9 12	HO1	8 10	PF6	11	PO9	8 10
GG1A	9 12	NN2	7	PO2	8 10	TG3	9 12
GO2	8 10	PF2	11	PO3	8 10	TG4	9 12
						TG8	9 12

Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 1 of 13)

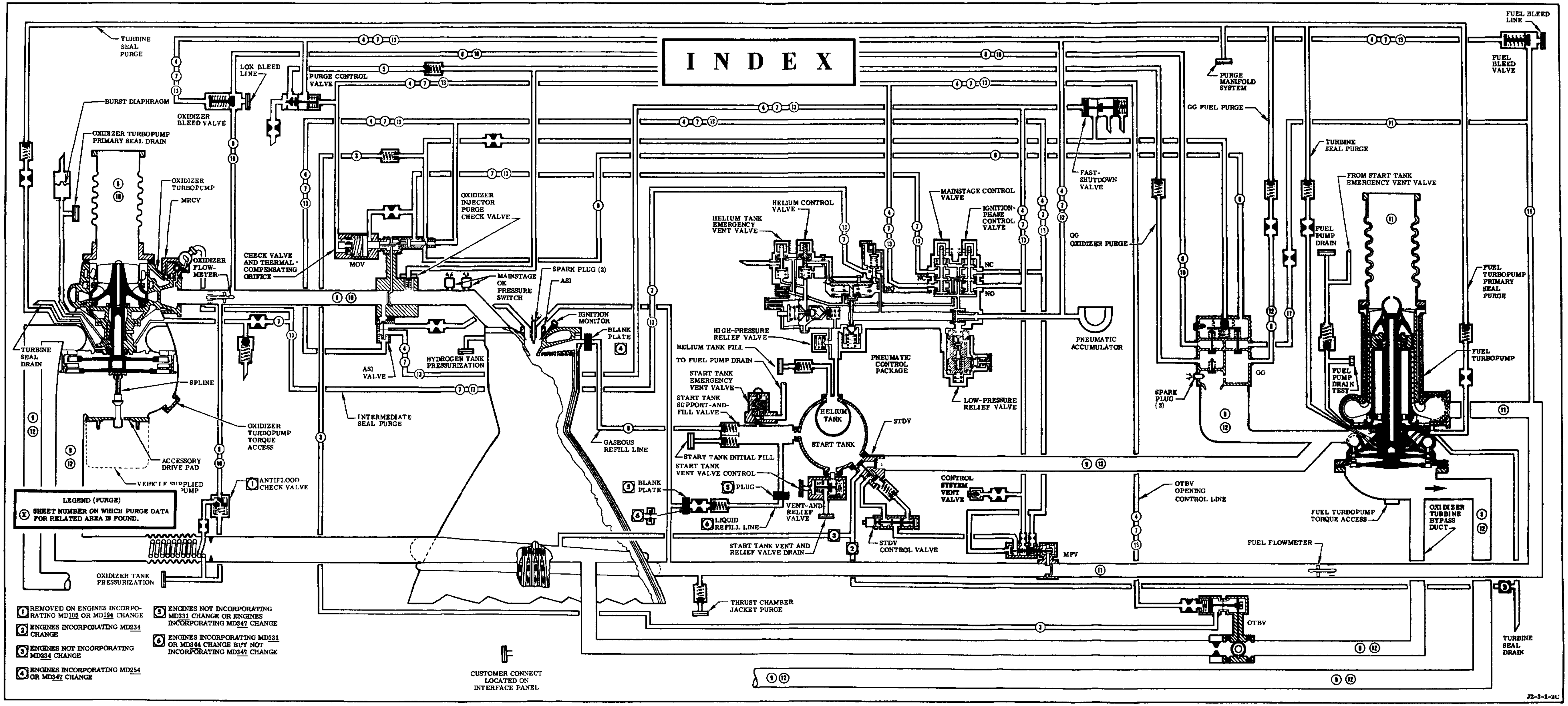


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 2 of 13)

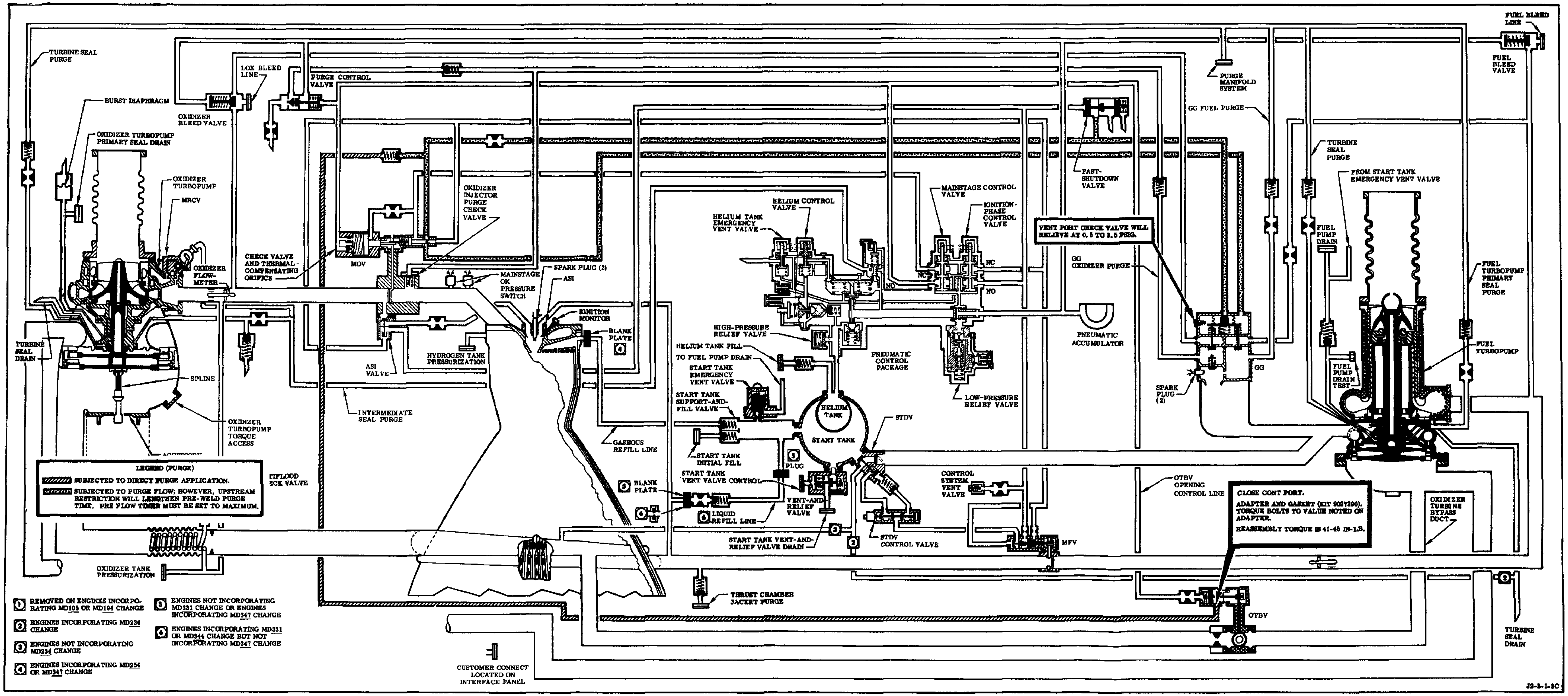


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 3 of 13)

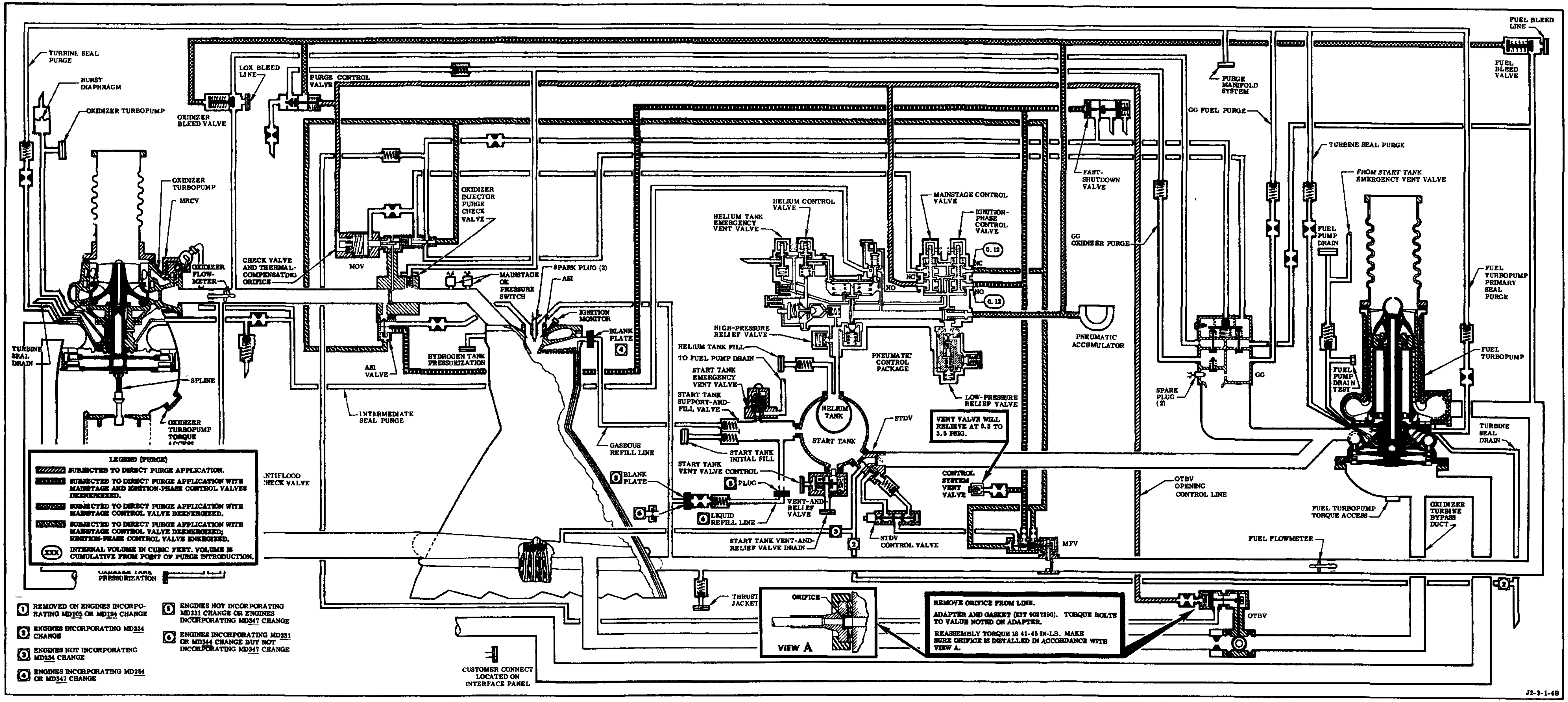


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 4 of 13)

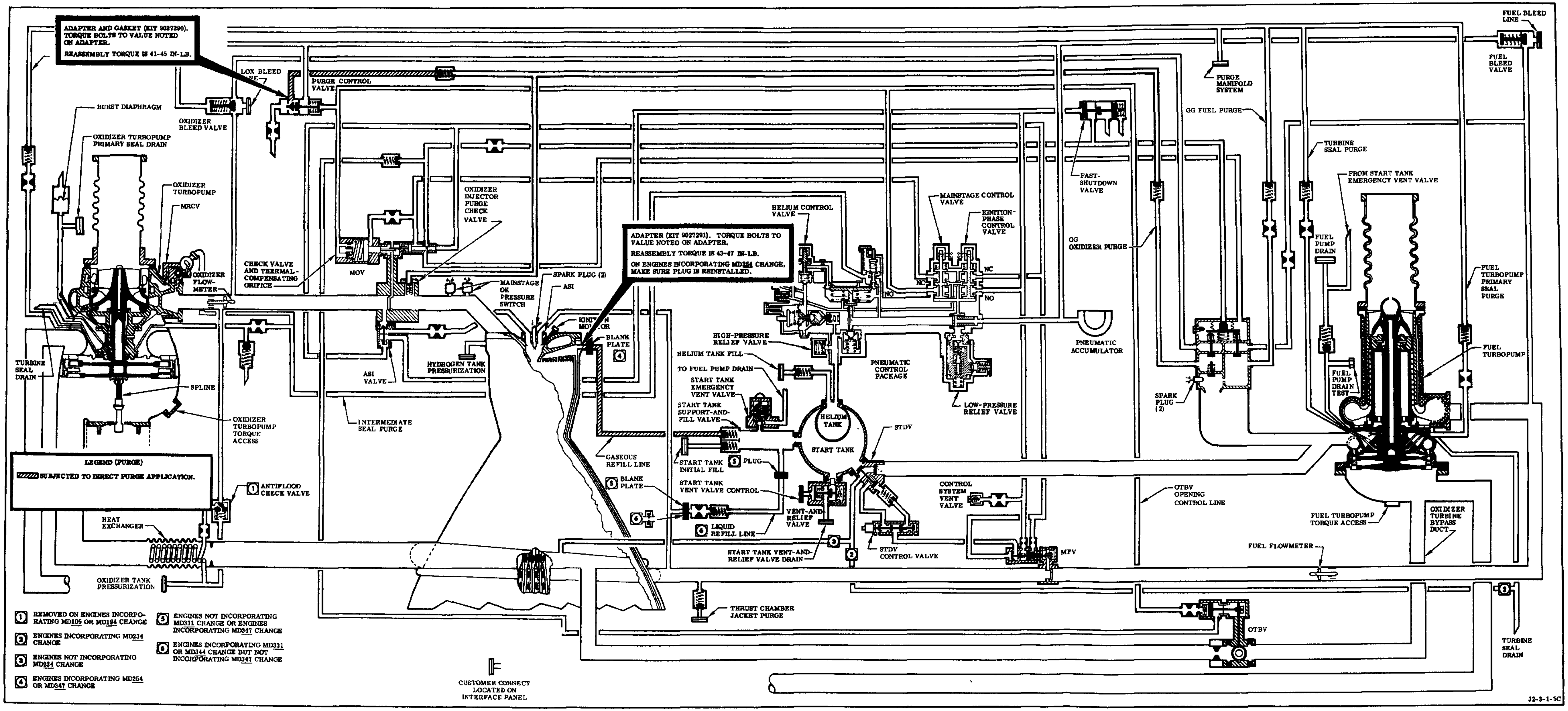


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 5 of 13)

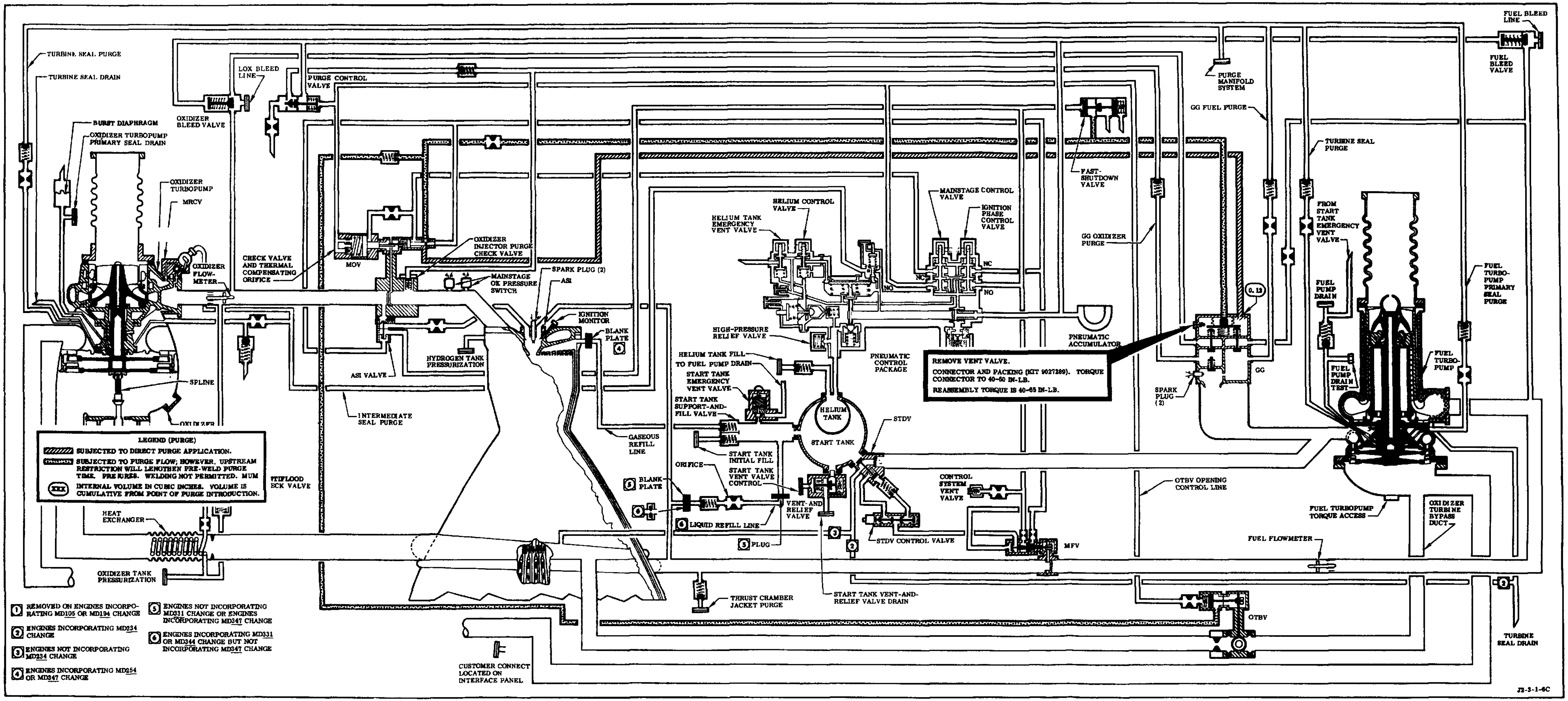


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 6 of 13)

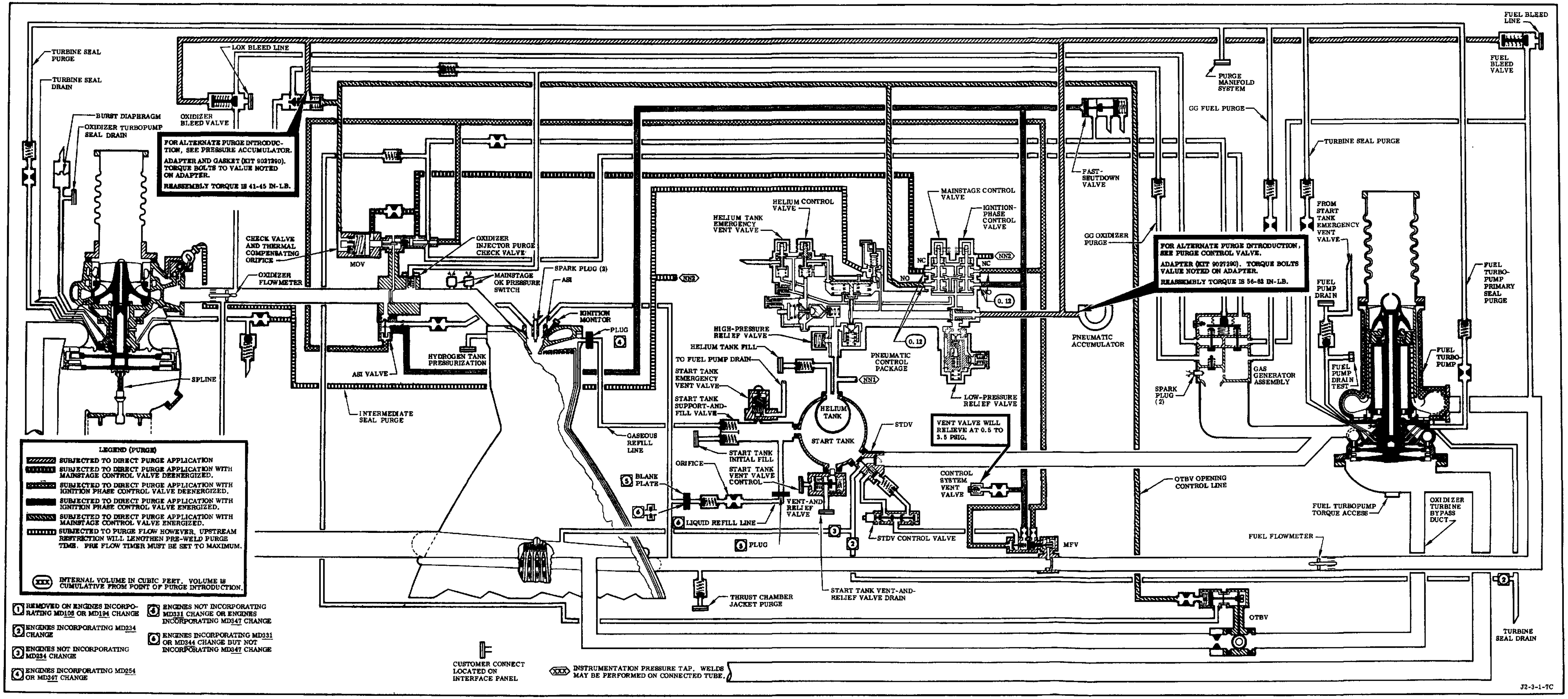


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 7 of 1[illegible])

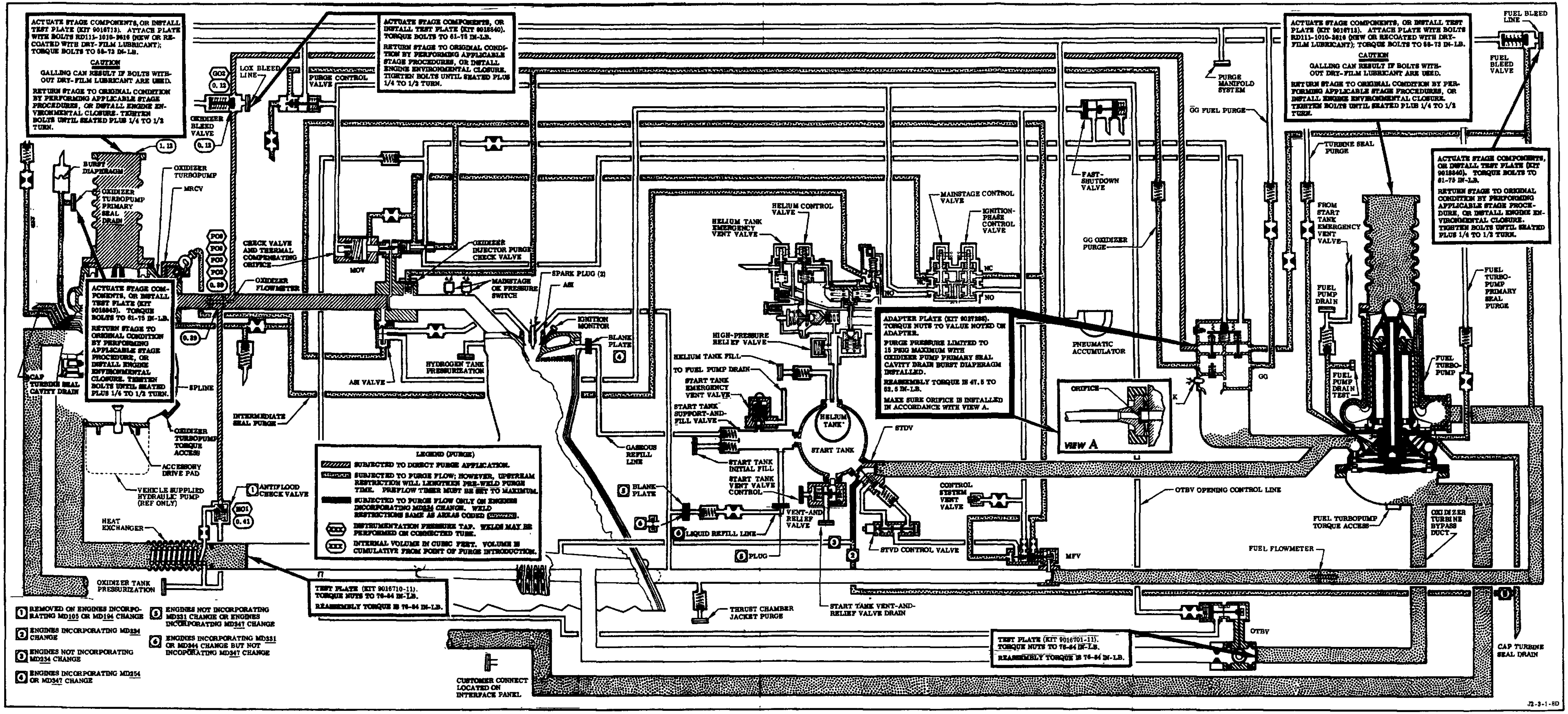


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 8 of 13)

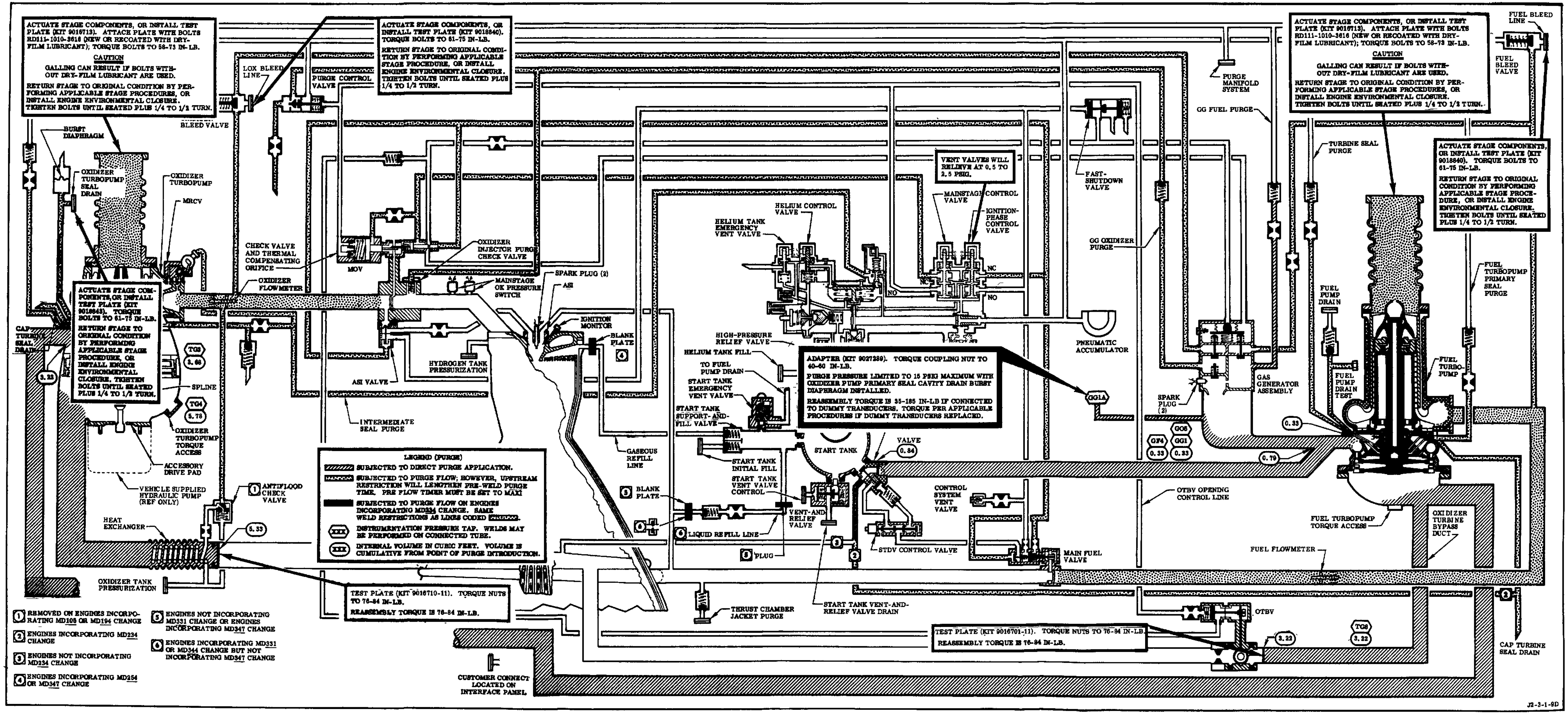


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 9 of 13)

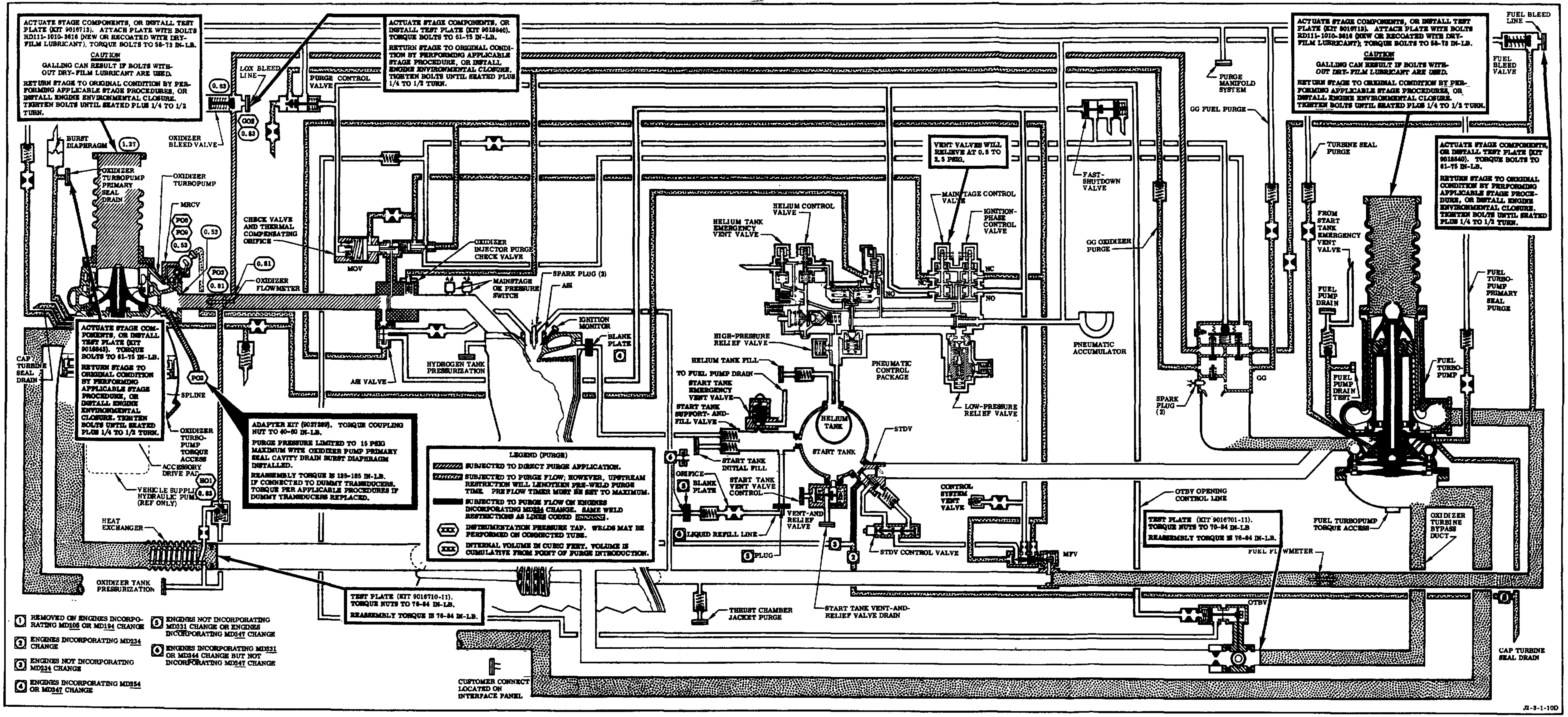


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 10 of 13)

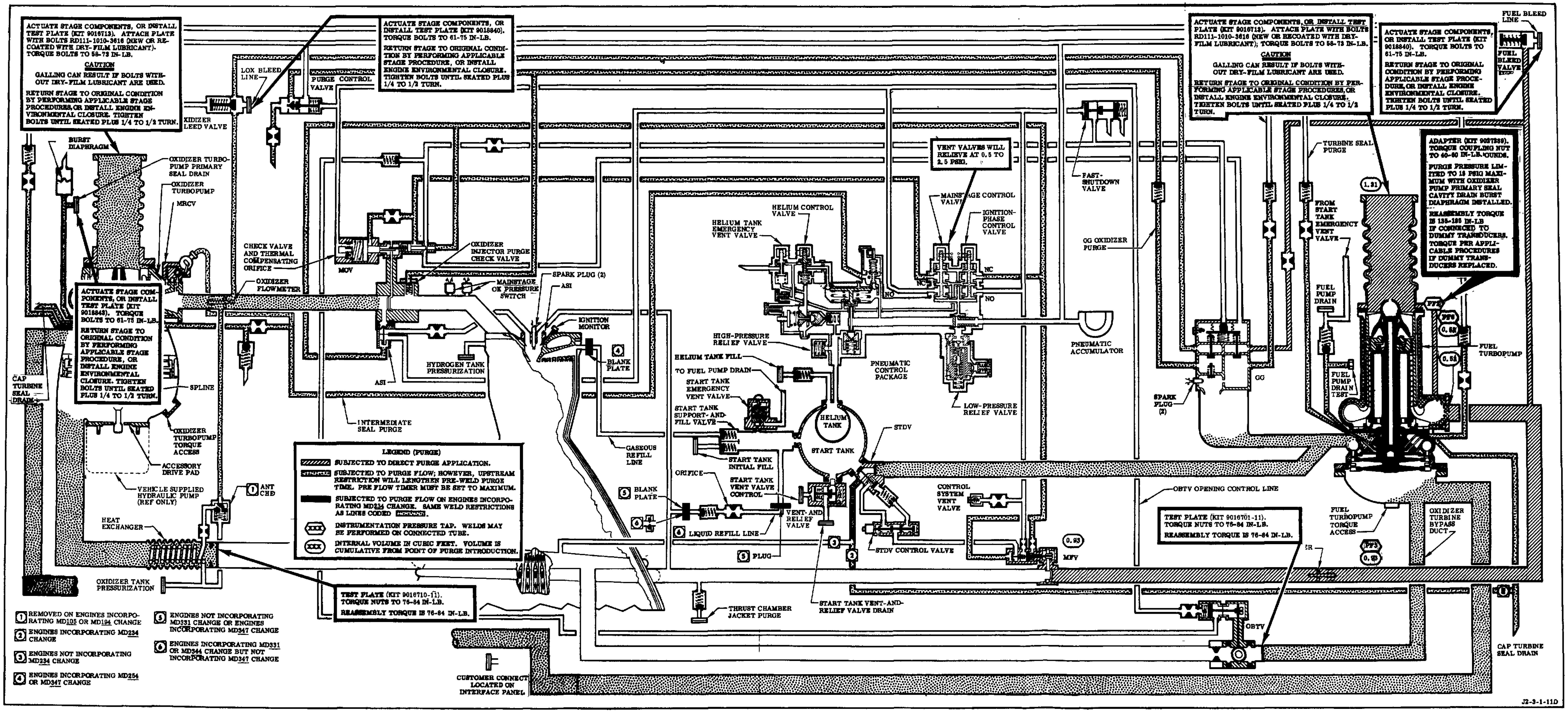


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 11 of 13)

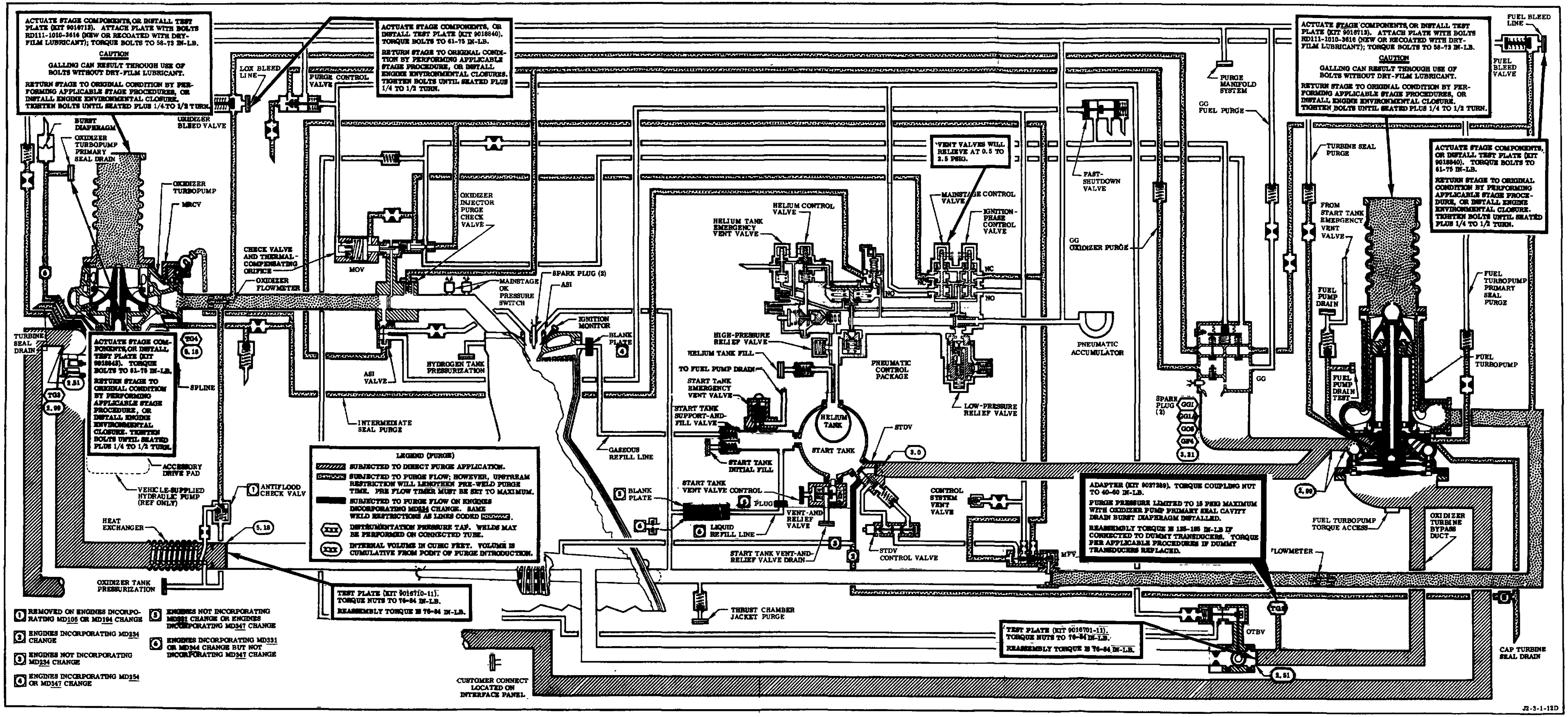


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 12 of 13)

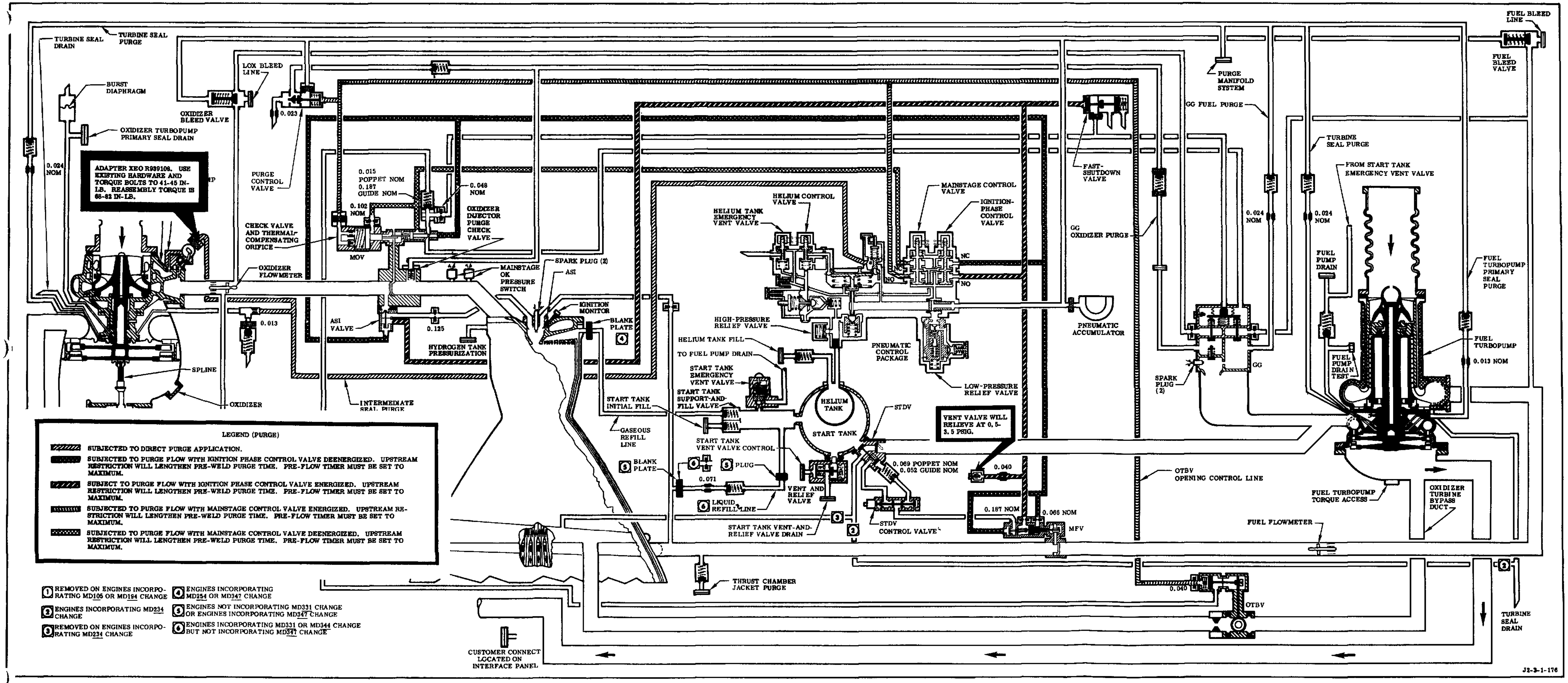


Figure 6-10. Engine Purge Schematics for In-Place Tube Welding (Sheet 13 of 13)

CAUTION

Pressure in excess of 30 psig can damage certain engine components.

d. Start pre-weld purge. If an alternate high-volume purge source is used, do not exceed 30 psig to engine. Pressures from G3128 purge panel are controlled and will not exceed 30 psig maximum.

e. If more than one weld is to be performed on engine system being purged, assemble all joints to be welded except joint furthest downstream (relative to purge flow). Assemble joints using parts that will be welded in place. Make sure parts are clean and ready for welding so that subsequent disassembly of these joints is not necessary. If necessary, parts may be held in position with pressure-sensitive tape RB0195-002 (Rocketdyne), or equivalent.

f. Route purge gases that exit from furthest downstream joint, to a convenient location for welding test specimens. A suggested method would be to use 2 tube adapters 9027317 (of appropriate dash numbers) interconnected with a 1/4-inch-diameter tube. (A length of flexible hose with short sections of 1/4-inch-diameter tubing attached to each end may be used.) (See figure 6-11 for a typical installation.) Make sure downstream side of joint is capped until joint is assembled for welding.

g. Maintain pre-weld purge until system purge is considered adequate; then weld test specimens in accordance with requirements and procedures of paragraph 6-8. If alternate high-volume source was used for purging, replace it with G3128 purge panel prior to welding. To minimize entrance of contaminating gases when changing purge sources, change sources with purge gases flowing, and keep period of time between disconnection and connection of purges to a minimum. If a tee connection is employed to permit transferring from the alternate high-volume source to the G3128 purge panel without disconnecting, make sure pressure produced by high-volume source is reduced to 10 psig or less before transferring to purge panel.

h. If engine system through which purge is flowing contains an orifice less than 0.125 inch in diameter, PRE FLOW timer must be set to maximum rather than value required in weld procedures.

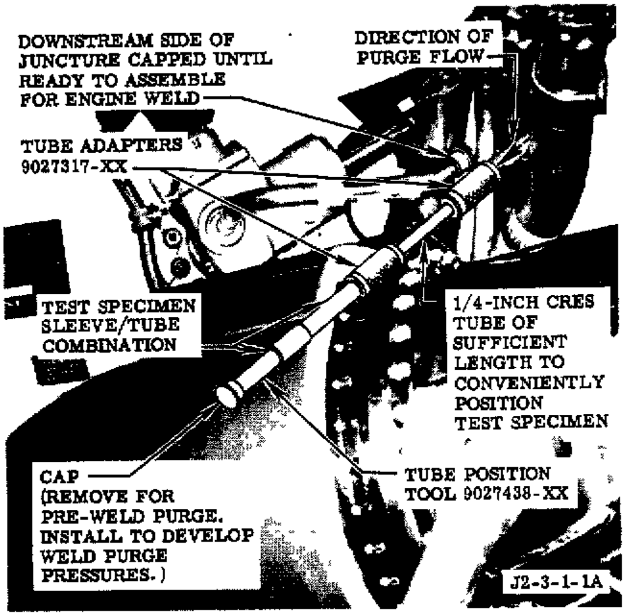


Figure 6-11. Purge Setup for Welding Test Specimens (Typical)

NOTE

With an orifice of 0.125 inch diameter or less in the system, setting the PRE FLOW timer to maximum assures adequate time for buildup of weld purge pressure and purge of weld joint.

i. Purge flowrates must not be manually changed during or between the welding of each acceptable test specimen and engine weld, except as necessary between welds to readjust purge pressures.

j. When acceptable test specimens have been obtained and the first engine joint to be welded is assembled and ready for welding, observe one of the two following requirements:

(1) If engine system being welded can be opened downstream of weld, open system and permit purge gas to flow for same period of time shown in weld schedule for preflow; then close system.

(2) If system being welded cannot be opened downstream, use 10 minutes for preflow instead of values in weld schedule.

NOTE

Additional flow purges the downstream side of the weld joint. Where flow conditions cannot be obtained, additional preflow time must be allowed to dilute the contaminating gases on the downstream side to an acceptable level.

6-18. PRE-WELD AND WELDING PURGE REQUIREMENTS FOR TUBE PLUGS. All requirements for in-place tube welding apply to welding plugs except the method for purging test specimens and the requirement for the reference line (figure 6-2). Test specimen(s) for the plug-to-sleeve combination and the sleeve-to-tube combination associated with the plug may be purged directly from the G3128 Purge Panel. However, when these test specimen(s) are purged in this manner, the following requirements must be observed:

a. Engine welds (related to plug installation only) must be purged by flowing the purge gases into the engine from the juncture to be welded.

b. The **PRE FLOW** timer must be set to 10 minutes rather than the time required by the weld schedule.

6-19. CUTTING TUBES AND STUB-OUTS.

6-20. Cutting tubes and stub-outs is required when removing engine components and/or sections of defective tubing. This task involves the parting of tubes by use of special tube cutters found in Single Head Special Tool Kit G3127. Precautionary measures contained in the following procedures prevent the introduction of airborne or external surface contamination and chips generated by the cutting process, and control location of the mass added by the sleeve by designating specific zones in which tube cuts can be made.

a. Determine where cuts are to be made. Make sure the following requirements are met in determining cut locations:

(1) Tubes must be cut in repair zone and in order of preference shown in figure 6-12.

(2) Stub-outs must be cut between the weld and the component only after it has been determined that sufficient stub-out will remain to permit rewelding. Determination of reweld capability can be made by reviewing the stub-out drawing and seeing figure 6-2.

(3) Plan cuts that result in minimum number of remaining weld joints practical after repair is complete.

(4) If a weld sleeve RD273-1023-XXXX is being removed to be replaced with a repair sleeve RD273-1029-XXXX, cuts must be planned within 9/32 inch of each end of weld sleeve being replaced. Exceeding 9/32 inch will leave a gap that cannot be connected with a repair sleeve and meet the tube insertion requirements of figure 6-2.

(5) Sufficient space must be available for installation of weld head. As an aid in determining space required, see figure 6-13 for envelope size of weld heads.

CAUTION

The addition of mass (weld sleeve) to a tube between a shot-peened weld and the first tube support can result in failure of the welded joint during an engine run.

(6) Do not plan cut on portion of tube between a component and first tube support if that portion of tube contains a shot-peened weld.

CAUTION

A permanently distorted tube can result in unsatisfactory engine operation.

b. Loosen or remove tube support clamps to provide sufficient flexibility to permit tube cutting and weld head installation without causing permanent tube distortion.

WARNING

The following procedure uses trichloroethylene and trichloroethane, which are toxic solvents. Inhalation of the vapors or prolonged contact with the liquids can cause serious injury or death.

- The following procedure uses cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

c. Clean tube cutter cutting wheel and rollers. Use nylon cloth dampened with solvent.

d. Clean area to be cut and welded. Use abrasive; then wipe with nylon cloth dampened with solvent.

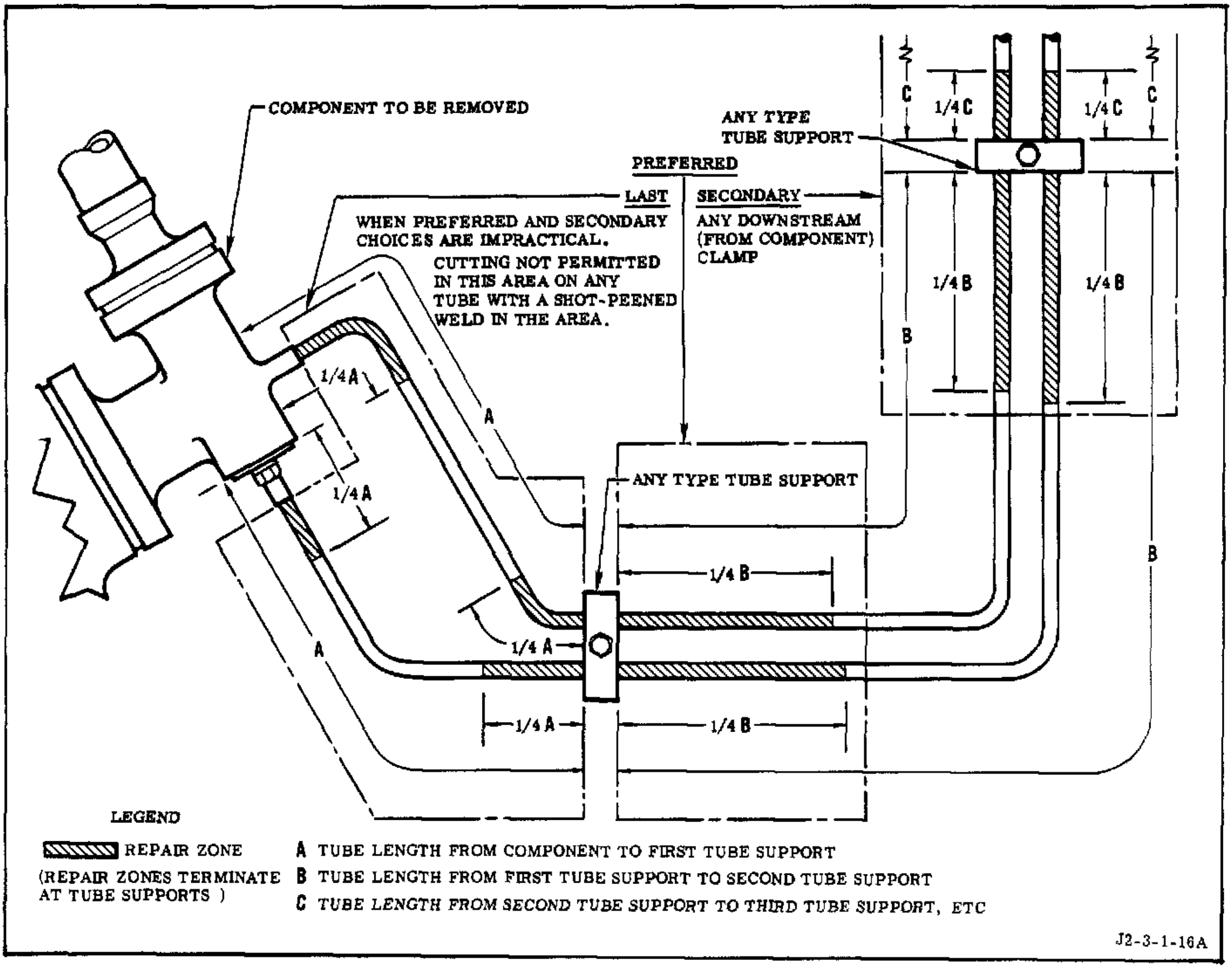


Figure 6-12. Tube Cutting Locations (Typical)

e. Cut tube or stub-out, observing the following:

(1) Wear clean nylon gloves.

(2) If practical, apply low-pressure purge (paragraph 6-16) before cutting tube. Maintain purge after cutting.

(3) Keep tube and surfaces of tube cutter that contact tube dry and unlubricated.

(4) If replacing a weld sleeve with a repair sleeve, cut as close as possible to, and under no condition more than 9/32 inch from, each end of weld sleeve. Exceeding 9/32 inch will leave a gap that cannot be connected with a repair sleeve and meet the tube insertion requirements of figure 6-2.

(5) When cutting, minimize tube distortion by increasing blade depth at a slow rate. Rotate cutters until cutters turn freely; then increase blade depth by rotating thumbscrew approximately 30 degrees. Repeat rotating cutter and then thumbscrew until tube is parted.

(6) After cutting, install a clean polyethylene bag or sheet material and secure in place with pressure-sensitive tape RB0195-002 (Rocketdyne). Make sure tape is installed far enough from cut so that weld area is protected. If low-pressure purge has been applied, leave side of cut from which purge gas is existing uncapped.

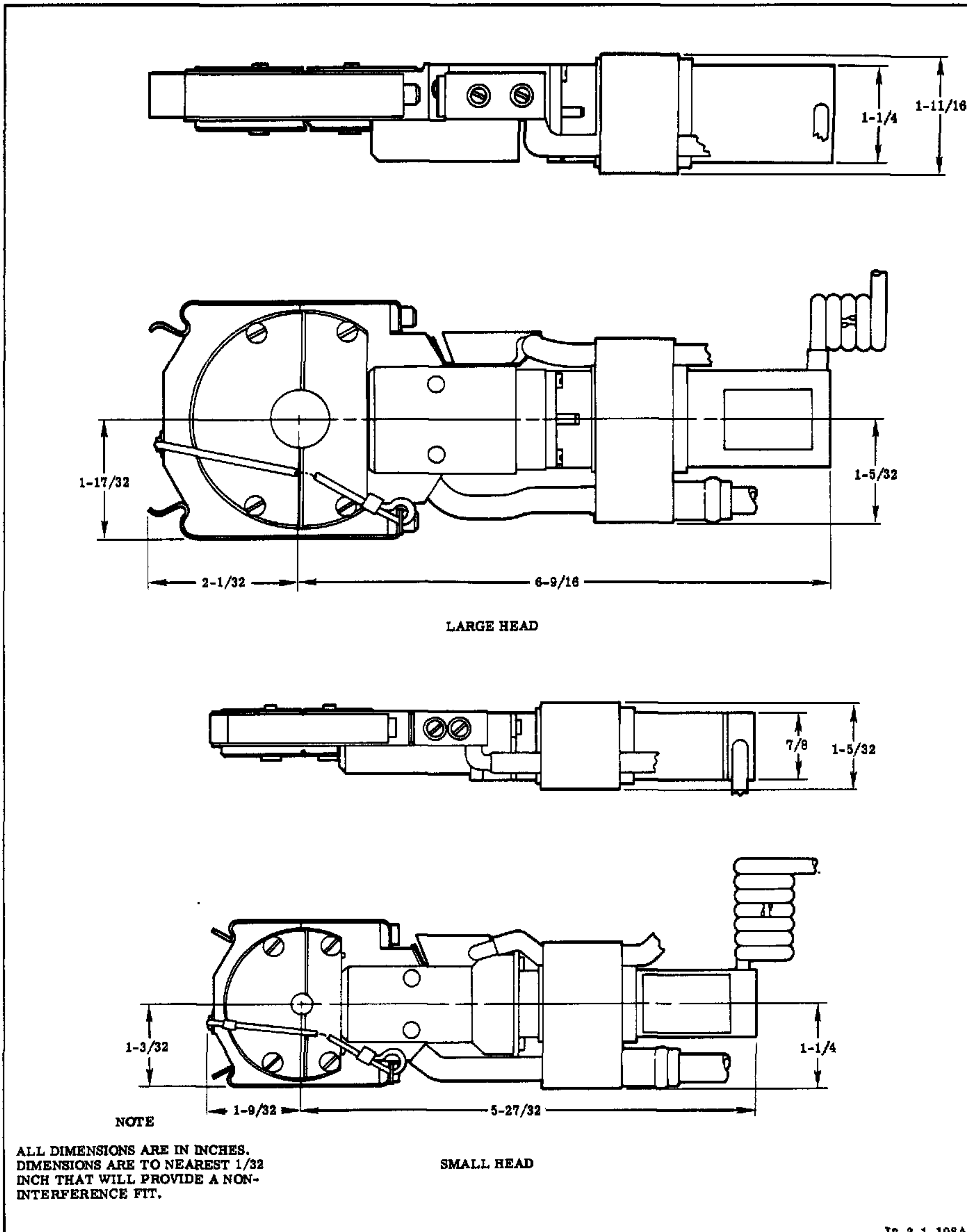


Figure 6-13. Weld Head Envelopes

(7) If doubtful as to whether cutter is functioning properly, make a sample cut. Correct cutter operation is verified by the following:

(a) A smooth cut with brightly polished sides

(b) A smooth rotating and cutting action

(c) No indication of cutter unseating from tube

(d) No evidence of chips, breaks, or hairline cracks on any part of cutter assembly upon completion of cut

(8) Do not ream tube or stub-out after cutting.

CAUTION

Particles of broken blade may be imbedded in the defective cut. Attempting to complete a cut that contains imbedded particles can fracture a new blade.

- Tubes in which a section in excess of 1/16 inch has been removed will not meet the minimum requirements for insertion into a weld sleeve and therefore cannot be welded.

(9) If tube cutter blade breaks, replace blade and cut tube or stub-out in another area so that defective cut is in section to be discarded. If section of tube is not to be discarded (original tube to be rewelded), make cuts on each side within 1/32 inch of defective cut and remove section of tube (1/16 inch maximum) containing defective cut. Never attempt to complete a cut in which a blade has been broken.

6-21. ADJUSTING ROTOR SPEED.

6-22. This task adjusts the speed of the weld head rotor to meet the rotor speed requirement of the weld procedure.

a. Welder and weld head must be prepared as outlined in paragraphs 6-12 and 6-14.

b. Set the following switches on speed controller to positions noted:

(1) LARGE HEAD/SMALL HEAD on rear panel to position corresponding to connected weld head

(2) AC to ON

(3) DC to FWD or REV

c. Set the following switches on welder to positions noted:

(1) PANEL REMOTE CURRENT to REMOTE

(2) PANEL REMOTE VOLTAGE to PANEL

(3) High frequency to OFF

(4) WELD DURATION to ON

(5) FIXTURE DELAY to ON

(6) SEQ. STOP to ON

(7) AUTOMATIC/MANUAL to AUTOMATIC

(8) Move MAIN CIRCUIT BREAKER to ON. Fan starts, light on controller comes on, and SPEED PERCENT meter may indicate a value. An indication on SPEED PERCENT meter is not required.

d. Set POST FLOW and FIXTURE DELAY timers to 1-2 seconds.

e. Move FIXTURE TIMING switch to ON.

f. Obtain required ROTOR SPEED time for combination to be welded. (See figure 6-1.)

g. Position SEQ. STOP and WELD DURATION timers so their combined setting is equal to time obtained in previous step.

NOTE

The combined time of SEQ. STOP and WELD DURATION timers determines the length of time the weld head motor will operate.

h. Press FIXTURE JOG button on remote control box to aline electrode with part line of weld head covers.

i. Momentarily press SEQ. STOP button on remote control box and check amount of rotor rotation. Weld head rotor starts to rotate when FIXTURE DELAY timer times out and continues until WELD DURATION and SEQ. STOP timers time out.

j. If rotor completed one revolution (+10, -0 degrees), the rotor speed requirement has been met. If rotor did not meet required rotation, unlock SPEED CONTROL and adjust rotor speed by increasing or decreasing SPEED CONTROL setting. Lock SPEED CONTROL and repeat steps h and i. Increasing SPEED CONTROL setting increases rotor speed. A SPEED CONTROL change of 80 (large head) or 56 (small head) nominally changes rotor speed 1/4 revolution.

6-23. ADJUSTING HEAD-TUBE DIFFERENTIAL PRESSURE.

6-24. To adjust head-tube differential pressure, proceed as follows:

a. Make sure HEAD PURGE REGULATOR and TUBE PURGE REGULATOR control knobs are turned to full DECR; then fully open shutoff and flow valves on purge gas bottles.

CAUTION

Exceeding flowmeter capacity can damage the instrument.

b. Slowly turn HEAD PURGE REGULATOR control knob to INCR until 1.9 to 2.0 inches of water is indicated on HEAD PRESSURE gage. Do not exceed capacity of flowmeter. If required pressure cannot be attained within flowmeter capacity, check system for leaks, restrictions, and excessive clearance of weldhead side plates.

NOTE

Flowmeters are used for indicating purposes only. Fluctuations are permitted if the differential pressure used in the weld schedule can be maintained.

c. Make sure cap is installed on tube position tool.

d. Obtain required tube differential pressure from figure 6-1.

e. Slowly turn TUBE PURGE REGULATOR control knob to INCR until HEAD/TUBE DIFF PRESS gage indicates required differential pressure. Do not exceed capacity of flowmeter. If required pressure cannot be obtained within flowmeter capacity, check system for leaks or restrictions.

NOTE

Some leakage will exist at sleeve-tube joint; however, excessive leakage may be due to improper positioning or incorrect sleeve-tube relationship.

- Fluctuations are permitted if the differential pressure used in the weld schedule can be maintained.

MANUAL DATA SUPPLEMENTS

Manual Data Supplements are issued from time to time to communicate important and urgent information concerning the equipment covered in this volume. These supplements bear an identifying number and should be filed in this Appendix.

Manual Data Supplements directly affect the data in this volume and will be incorporated into this volume during a future updating effort.

A Supplement Record is issued periodically to indicate the status of supplements issued for this volume. The status of each supplement is indicated in the "Supplement Status" column. For active supplements, no status is entered. For incorporated supplements "Incorporated" is entered.

Upon receipt of a Manual Data Supplement make an appropriate reference to the supplement in the margin next to the data supplemented and enter the number, date, and subject matter of the supplement in the Manual Data Supplement Record. Supplements that have been incorporated into this volume shall be discarded.

MANUAL DATA SUPPLEMENT RECORD

This Supplement Record indicates the status of supplements issued for Technical Manual R-3825-3 Volume I. Supplements which have been incorporated into the volume shall be removed from the Appendix and destroyed.

Supplement Number	Dated	Description	Supplement Status
1	24 May 1965	Adds procedure for potting electrical harnesses.	Incorporated
2	18 June 1965	Adds procedure for ignition detector probes.	Incorporated
3	20 August 1965	Adds caution on electrical connector seals and spacers.	Incorporated
4	7 September 1965	Adds information on disconnecting, connecting, and protecting electrical connectors.	Incorporated
R-3825-3-5	12 October 1965	Changes torque value in diffuser installation procedure.	Incorporated
R-3825-3-6	5 November 1965	Adds pressure retention test for electrical control package and flight instrumentation packages. (Service Data)	Canceled
R-3825-3-7	7 December 1965	Changes maintenance and repair procedures for armored harness.	Incorporated
R-3825-3-8	16 December 1965	Adds information for Engine Handler G4064.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3-9	6 January 1966	Provides interim procedures for thrust chamber purge lines modified by ECP J2-465.	Incorporated
R-3825-3-10	9 February 1966	Adds GG spark igniter cable leak-test requirements	Superseded by R-3825-3-12
R-3825-3-11	16 February 1966	Updates welding procedures.	Superseded by R-3825-3-17
R-3825-3-12	18 February 1966	Clarifies engine effectivities, and supersedes supplement R-3825-3-10. (Service Data)	Superseded by R-3825-3-24
R-3825-3-13	22 February 1966	Notifies field of problem in using 9022284 Wrench Kit. (Service Data)	Canceled
R-3825-3-14	23 February 1966	Corrects MFV test adapter set installation information.	Incorporated
R-3825-3-15	1 March 1966	Corrects dead-end purge requirements in welding procedure.	Superseded by R-3825-3-17
R-3825-3-16	3 March 1966	Instructs field to replace mainstage OK pressure switches on engines J-2016 and J-2019. (Service Data)	Canceled
R-3825-3-17	8 March 1966	Supersedes supplements R-3825-3-11 and R-3825-3-15. Adds reweld cycle requirements, and clarifies dead-end purge requirements.	Incorporated
R-3825-3-18	24 March 1966	Adds oxidizer turbopump turbine requirements.	Incorporated
R-3825-3-19	1 April 1966	Advises field of improved method for removing and installing thrust chamber skin temperature transducers. (Service Data)	Canceled
R-3825-3-20	25 April 1966	Adds procedure for measuring and recording pressure in spark igniter cables.	Superseded by R-3825-3-25
R-3825-3-21	18 April 1966	Adds requirements and instructions for performing inspection and swab test of turbine end of oxidizer turbopump.	Incorporated
R-3825-3-22	28 April 1966	Adds additional instructions for removing and installing heat exchanger.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3-23	28 April 1966	Adds requirements and additional instructions for using Engine Vertical Installer G4035.	Incorporated
R-3825-3-24	5 May 1966	Supersedes Supplement R-3825-3-12. Clarifies requirements and expands the procedures for leak-testing GG spark igniter cables. (Service Data)	Canceled
R-3825-3-25	5 May 1966	Establishes requirements and procedures for measuring and recording pressure in spark igniter cables.	Incorporated
R-3825-3-26	16 May 1966	Adds inspection requirements and repair procedures for insulation on fuel duct and line and on thrust chamber jacket purge line.	Incorporated
R-3825-3-27	10 June 1966	Adds instructions for handling, installing, and removing pressure-actuated (Naflex) seals.	Incorporated
R-3825-3-28	30 June 1966	Adds warning against operation of Automatic Inert Gas Arc Welding Set G3128 in a wet environment.	Incorporated
R-3825-3-29	18 July 1966	Adds inspection requirements and instructions for repairing cracks in turbine exhaust manifold drain boss.	Incorporated
R-3825-3-30	15 July 1966	Deletes use of Rotating Sling Assembly G4062 and adds use of Turbopump Sling G4046.	Incorporated
R-3825-3-32	17 August 1967	Adds visual and mechanical checks to fuel turbopump procedure to prevent installation of first-stage turbine wheel backwards.	Incorporated
R-3825-3-33	19 September 1966	Updates thrust chamber damage limits.	Incorporated
R-3825-3 Vol I-1	6 October 1966	Adds new torque requirements for bolts on oxidizer turbine inlet flange.	Incorporated
R-3825-3 Vol I-2	13 October 1966	Changes cleaning requirements for parts prior to dye-penetrant inspection.	Incorporated
R-3825-3 Vol I-3	7 November 1966	Adds procedure for leak-testing and pressurizing spark igniter cables on engines incorporating MD<u>244</u> change.	Superseded by R-3825-3 Vol I-10
R-3825-3 Vol I-4	1 November 1966	Changes test procedures on engines incorporating MD<u>234</u> and MD<u>204</u> changes.	Superseded by R-3825-3 Vol I-26

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-5	27 January 1967	Adds procedures for engines incorporating MD244 change, and changes procedures for engines not incorporating MD244 change, for removing and installing ECA.	Incorporated
R-3825-3 Vol I-6			Not issued
R-3825-3 Vol I-7	16 November 1966	Changes inspection procedures for thrust chamber turbine exhaust manifold drain bosses.	Incorporated
R-3825-3 Vol I-8	27 December 1966	Adds requirement and procedures for reverse-leak-testing swing gate.	Incorporated
R-3825-3 Vol I-9	8 December 1966	Adds procedures for leak-testing STDV piston and piston lip seals.	Incorporated
R-3825-3 Vol I-10	30 January 1967	Supersedes Supplement R-3825-3 Vol I-3 and adds procedures for leak-testing igniter cable spark plugs and repairing spark igniter cable pressurizing tubes.	Incorporated
R-3825-3 Vol I-11	20 February 1967	Replaces Supplement R-3825-3 Vol I-17, and changes method of removing moisture from ASI chamber pressure instrumentation line on engines incorporating MD276 or MD277 change.	Incorporated
R-3825-3 Vol I-12	19 December 1966	Adds procedures for removing and removing and installing fuel turbine inlet temperature transducer and for refinishing fuel turbine inlet temperature and GG overtemperature transducer bosses.	Incorporated
R-3825-3 Vol I-13	21 December 1966	Adds requirement and procedures for replacing ASI oxidizer line support clamp and bracket.	Incorporated
R-3825-3 Vol I-14	9 January 1967	Changes leak-test procedures for personnel safety, and changes fuel turbine seal leakage limits.	Superseded by R-3825-3 Vol I-27
R-3825-3 Vol I-15	6 January 1967	Adds procedure for orificing the MOV thermostatic orifice check valve.	Incorporated
R-3825-3 Vol I-16	18 January 1967	Changes type of dye-penetrant developer used for inspection.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-17	27 January 1967	Adds requirements and procedure for purging ASI chamber pressure instrumentation line.	Superseded by R-3825-3 Vol I-11
R-3825-3 Vol I-18	10 February 1967	Adds requirements to remove and retain seal locating screws when replacing STDV control valve.	Incorporated
R-3825-3 Vol I-19	22 February 1967	Adds removal and installation procedures for ASI and GG spark igniter cables.	Incorporated
R-3825-3 Vol I-20	7 February 1967	Adds torque values, safetywire requirements, and nomenclature for bolts on Engine Handler G4064.	Incorporated
R-3825-3 Vol I-21	17 February 1967	Adds in-place fillet weld procedures for Automatic Inert Gas Arc Welding Set G3128.	Incorporated
R-3825-3 Vol I-22	13 April 1967	Changes leak-test procedures for spark igniter cables on engines incorporating MD244 change.	Incorporated
R-3825-3 Vol I-23	10 March 1967	Adds spark igniter cable pressure-measuring procedure for engines incorporating MD244 change.	Incorporated
R-3825-3 Vol I-24	8 March 1967	Adds leak-testing and pressurizing procedures for instrumentation packages using equipment designed per ECP J2-512.	Incorporated
R-3825-3 Vol I-25	14 February 1967	Adds removal and installation procedures for ignition detector probe;	Incorporated
R-3825-3 Vol I-26	29 March 1967	Supersedes Supplement R-3825-3 Vol I-4, and changes test procedures for engines incorporating MD234 and MD204 changes.	Incorporated
R-3825-3 Vol I-27	11 April 1967	Changes leak-test procedures for personnel safety, and changes turbine seal leakage limits.	Incorporated
R-3825-3 Vol I-28	24 February 1967	Adds requirements and procedures for pressure-decay-testing mainstage OK pressure switches.	Superseded by R-3825-3 Vol I-29
R-3825-3 Vol I-29	2 March 1967	Replaces Supplement R-3825-3 Vol I-28, and adds requirements and procedures for pressure-decay-testing mainstage OK pressure switches.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-30	21 March 1967	Adds safety procedures for grounding engine vertical installer.	Incorporated
R-3825-3 Vol I-31	17 March 1967	Adds procedure for installing thrust chamber throat plug from Thrust Chamber Throat Plug Kit G3120MD3.	Incorporated
R-3825-3 Vol I-32	30 March 1967	Changes MOV sequence-timing requirement.	Incorporated
R-3825-3 Vol I-33	31 March 1967	Changes torque requirements on helium high-pressure relief valve mounting bolts.	Incorporated
R-3825-3 Vol I-34	17 April 1967	Changes test hookup and inlet pressures to thrust chamber from Pneumatic Console G3106.	Incorporated
R-3825-3 Vol I-35	18 April 1967	Adds requirement for resistance-testing ignition detector probe.	Incorporated
R-3825-3 Vol I-36	17 April 1967	Changes fuel turbine seal leakage limits.	Incorporated
R-3825-3 Vol I-37	15 June 1967	Adds requirements for energizing, deenergizing, and recording pressure levels of each cycle of helium regulator.	Canceled
R-3825-3 Vol I-38	13 June 1967	Adds helium supply and start system high-pressure test.	Incorporated
R-3825-3 Vol I-39	17 July 1967	Adds type of abrasive cloth to be used for cleaning tubes prior to welding.	Incorporated
R-3825-3 Vol I-40	21 July 1967	Adds requirements for inspecting fuel inlet duct convolutions spacing.	Incorporated
R-3825-3 Vol I-41	2 August 1967	Adds requirements, procedure, and tool for inspecting weld sleeves, tees, and fittings prior to welding.	Incorporated
R-3825-3 Vol I-42	7 August 1967	Adds requirement to torque injector purge check valve prior to installing on MOV.	Incorporated
R-3825-3 Vol I-43	14 August 1967	Removes safetywire requirement, changes valve and packing callout, changes references, adds a caution to test procedures, and changes out-of-alinement tolerances for oxidizer and fuel inlet ducts.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-44	18 August 1967	Changes STDV closing time, and adds orifice data for control of opening time.	Incorporated
R-3825-3 Vol I-45	24 August 1967	Changes MOV removal and installation procedures to include removal and installation of mainstage OK pressure switch No. 2 adapter.	Incorporated
R-3825-3 Vol I-46	28 August 1967	Replaces Supplement R-3825-3 Vol I-39, and deletes specification requirements for 320-grit (or finer) silicon-carbide abrasive cloth.	Incorporated
R-3825-3 Vol I-47	21 December 1967	Adds removal and installation procedures for transducers NA5-27323T6.	Incorporated
R-3825-3 Vol I-48	26 September 1967	Replaces leak-testing and pressurizing procedure for spark igniter cables (engines incorporating MD244 change) and ECA and FI packages, and incorporates leak testing of pressurizing valve seat.	Incorporated
R-3825-3 Vol I-49	18 January 1968	Adds requirements for testing helium system after welding of lines.	Incorporated
R-3825-3 Vol I-50	8 January 1968	Adds requirements for energizing, deenergizing, and recording pressure levels of each helium regulator cycle.	Incorporated
R-3825-3 Vol I-51	16 October 1967	Changes procedure for orificing MOV thermostatic orifice check valve assembly and procedure for in-place tube welding.	Incorporated
R-3825-3 Vol I-52	30 October 1967	Adds data to enable evaluation of preweld purge requirements and an optional leak test of the ASI cables.	Incorporated
R-3825-3 Vol I-53	30 January 1968	Adds requirements to install insulators on electrical connector pins.	Incorporated
R-3825-3 Vol I-54	15 March 1968	Adds new requirements to spark igniter cable repair procedure for cables that do not accept pressure.	Incorporated
R-3825-3 Vol I-55	16 April 1968	Adds requirements for removing and installing orifice plates at MFV and MOV control ports.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-56	17 May 1968	Adds requirements to turn off electrical power to engine when connecting or disconnecting electrical connectors or igniter cables and when igniter cables are disconnected, and deletes note that requires an engine sequence test only under certain conditions.	Incorporated
R-3825-3 Vol I-57	1 May 1968	Adds inspection procedures and damage limits for exciter output adapters.	Incorporated
R-3825-3 Vol I-58	24 May 1968	Adds torque requirements for oxidizer and fuel bleed valves, and GG fuel feed line attach bolts.	Incorporated
R-3825-3 Vol I-59	12 June 1968	Changes thrust chamber leak-test procedure to incorporate ECP 643, and adds a symbol to FI calibration charts.	Incorporated
R-3825-3 Vol I-60	20 June 1968	Adds procedural requirements for using engine vertical installer incorporating MD4 change, adds part numbers of vertical installer engine attach brackets, and changes flange gap tolerance for oxidizer and fuel inlet ducts.	Incorporated
R-3825-3 Vol I-61	11 July 1968	Adds procedural requirements for using Engine Forward Sling G4042MD1.	Incorporated
R-3825-3 Vol I-62	16 August 1968	Adds a permissible deviation to preweld purge requirements when in-place-welding plugs 704386.	Superseded by R-3825-3 Vol I-63
R-3825-3 Vol I-63	20 September 1968	Adds a permissible deviation to preweld purge requirements when in-place-welding plugs 704386.	Incorporated
R-3825-3 Vol I-64	22 September 1968	Adds procedural requirements for inspecting start tank for contamination and requirements for cleaning the tank, if required, anytime the STDV is removed. If STDV is to be replaced, certain components must be removed from old valve and retained for installation on replacement valve.	Incorporated
R-3825-3 Vol I-65	28 October 1968	Deletes procedural requirement to remove ECA prior to removing helium regulator assembly (pneumatic control package)	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-66	11 November 1968	Changes oxidizer bleed valve procedures to provide for removing and installing valve and GG oxidizer line as an integral component, as well as for removing and installing oxidizer bleed valve only, and adds requirement to perform a start system weld integrity test when start tank liquid refill line or TF1 instrumentation line is cut and welded, after stage acceptance test.	Incorporated
R-3825-3 Vol I-67	11 November 1968	Adds support clamp inspection and installation requirements and criteria for engine electrical harnesses and for lines of less than 2.00 inches OD.	Superseded by R-3825-3 Vol I-72
R-3825-3 Vol I-68	25 November 1968	Changes post-installation test requirements for helium regulator assembly to agree with procedural changes for removal and installation of the regulator; changes post-installation test requirements for temperature transducers TGT1, TGT3, and TGT4 to conform to changes in engine instrumentation configuration; adds requirements to provide post-installation testing for oxidizer bleed valve GG oxidizer line integral assembly and adds post-installation test requirements for interface electrical connectors on stage-installed engines.	Incorporated
R-3825-3 Vol I-69	4 December 1968	Changes procedural requirements when installing SII center engine in stage, changes fuel and oxidizer inlet duct torque requirements, changes removal and installation procedures for the start tank support-and-fill valve and changes removal and installation procedures for primary and auxiliary FI package transducers (to incorporate requirements of ECP J2-647).	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-70	6 March 1969	Changes procedural requirements when installing the SII center engine in stage, changes fuel and oxidizer inlet duct torque requirements, changes removal and installation procedures for the start tank support-and-fill valve, changes removal and installation procedures for primary and auxiliary FI package transducers (to incorporate the requirements of ECP J2-647), and changes removal and installation procedures for GG control valve, and adds procedures for removing and installing the gas generator control valve; and adds procedures for removing and installing GG control valve potentiometer.	Incorporated
R-3825-3 Vol I-71	31 January 1969	Provides a permissible substitute when replacing instrumentation system tees 703096.	Incorporated
R-3825-3 Vol I-72	11 February 1969	Adds support clamp inspection and installation requirements and criteria for engine electrical harnesses and for lines of less than 2.00 inches OD.	Incorporated
R-3825-3 Vol I-73	12 March 1969	Adds procedures for cleaning protective closures.	Incorporated
R-3825-3 Vol I-74	28 February 1969	Deletes use of fast-curing catalyst RTV-9891.	Incorporated
R-3825-3 Vol I-75	3 March 1969	Changes start tank vent-and-relief valve removal and installation procedures to add requirements to remove control line and valve as an assembly on engines that have a filter in control line and on engines that do not have filters in control line, if reweld capabilities cannot be maintained.	Incorporated
R-3825-3 Vol I-76	2 May 1969	Changes connector installation requirements by adding a constraint not to check installed connectors for torque relaxation and not to retorque connectors after connector installation has been completed.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-77	13 May 1969	Adds a resistance test of ignition-phase mainstage and STDV control valves, to preinstallation requirements.	Incorporated
R-3825-3 Vol I-78	9 May 1969	Changes removal and installation procedures for PU valve vent port check valve.	Incorporated
R-3825-3 Vol I-79	26 May 1969	Requires that untested weld joints be considered as open ports and that contamination protection be provided for such weld joints.	Superseded by R-3825-3 Vol I-82
R-3825-3 Vol I-80	24 June 1969	Adds information to clarify installation of orifices, and changes installation procedures for MOV.	Superseded by R-3825-3 Vol I-81
R-3825-3 Vol I-81	25 July 1969	Supersedes Supplement R-3825-3 Vol I-80, and adds torque information for nuts on support linkage of customer-connect line bar assemblies, adds information to change installation procedures for MOV, and adds insulation information to oxidizer bleed line installation procedure.	Incorporated
R-3825-3 Vol I-82	30 July 1969	Supersedes Supplement R-3825 Vol I-79, and requires that untested weld joints be considered as open ports and that contamination protection be provided for such weld joints.	Incorporated
R-3825-3 Vol I-83	22 September 1969	Adds procedures for removing and installing insulation on fuel bleed line and mounting bracket.	Incorporated
R-3825-3 Vol I-84	23 September 1969	Adds procedures for removing and installing oxidizer turbine bypass valve position indicator.	Incorporated
R-3825-3 Vol I-85	3 October 1969	Changes accuracy requirement of resistance-measuring device and reduces acceptable resistance tolerances for ignition detector probe.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-86	9 October 1969	Corrects heli-coil insert internal nominal thread size, revises procedure for installing oxidizer high-pressure duct (stacked SII stage), adds requirements to remove protective material from mating flanges in component installation procedures, and adds protective material for tube ends that were cut using chipless tube cutter.	Incorporated
R-3825-3 Vol I-87	4 November 1969	Supersedes supplement R-3825-3 Vol I-83 dated 22 September 1969 and changes adhesive sealant RTV-108 to RTV-102.	Incorporated
R-3825-3 Vol I-88	25 November 1969	Changes spot-check developer used for dye-penetrant inspection, and changes lubricant used on GG oxidizer injector poppet.	Incorporated
R-3825-3 Vol I-89	26 November 1969	Adds timing information for STDV 304386 when installed as a spares replacement.	Incorporated
R-3825-3 Vol I-90	1 December 1969	Adds procedures for removing and installing MOV position indicator.	Incorporated
R-3825-3 Vol I-91	5 December 1969	Adds procedures for removing and installing MOV position indicator.	Incorporated
R-3825-3 Vol I-92	10 December 1969	Revises helium supply filter requirements, adds a caution on torquing threaded fasteners when installing protective closures, and deletes swing gate leak test from post-installation test requirements for STDV.	Incorporated
R-3825-3 Vol I-93	23 December 1969	Adds a caution and a note to start system weld integrity test requirements.	Incorporated
R-3825-3 Vol I-94	9 January 1969	Replaces existing procedure for removing and installing heat exchanger antiflood check valve with a procedure that eliminates requirement to cut and reweld oxidizer inlet line to antiflood check valve when removing and reinstalling heat exchanger inlet manifold filter, and adds requirement to determine stud movement during removal of filter retaining stud.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-95	5 February 1970	Adds a requirement to measure gap between the turbopump volute and turbine manifold before attempting to remove the transducer, and adds a figure to show where gap is to be measured.	Incorporated
R-3825-3 Vol I-96	6 March 1970	Relocates 3 substeps relative to bonding P2650 tape in the procedure for installing fuel bleed line and mounting bracket insulation.	Incorporated
R-3825-3 Vol I-97	24 March 1970	Replaces Heat Exchanger Inlet Manifold Filter Installation Procedure.	Incorporated
R-3825-3 Vol I-98	30 March 1970	Adds data on modification to Single Head Special Tool Kit G3127, per ECP J2-635, and adds requirements for configuration of the weld head electrode.	Incorporated
R-3825-3 Vol I-99	27 March 1970	Adds procedures for removing and installing the oxidizer and fuel flowmeter pickups, and the post-installation test requirements for the pickups.	Incorporated
R-3825-3 Vol I-100	3 April 1970	Changes installation instructions for vent port check valves.	Incorporated
R-3825-3 Vol I-101	22 September 1970	Adds procedures and an illustration for disconnecting and connecting bayonet-type electrical connectors, adds procedures and an illustration for removing and installing the mixture ratio control valve, and changes post-installation test requirements for the mixture ratio control valve.	Incorporated
R-3825-3 Vol I-102	7 October 1970	Adds requirements and procedures for flow testing the turbine seal purge line orifice sleeve before installation.	Incorporated
R-3825-3 Vol I-103	29 October 1970	Adds (1) requirement to check pressure in ECA and FI packages before they are installed, (2) removal and installation procedures and test requirements for pressurizing valves, (3) inspection requirements of helium regulator orifices, (4) an audible	Incorporated

Supplement Number	Dated	Description	Supplement Status
		actuation verification test (click test) for MRCV and start tank emergency vent control valves, and (5) changes fuel and oxidizer inlet duct removal and installation procedures.	
R-3825-3 Vol I-104	4 November 1970	Adds requirement to replace sealing grommet when SICs NA5-27448 or NA5-27448T1 are disconnected from ECA, and an inspection to make sure a sealing grommet is not in ECA exciter output adapter cavity.	Incorporated
R-3825-3 Vol I-105	13 November 1970	Adds removal and installation procedures and test requirements for MRCV position indicator.	Incorporated
R-3825-3 Vol I-106	4 December 1970	Clarifies replacement of dielectric spacer in bayonet-type connectors, revises installation procedures of protective covers on inlet duct torsional rings, and adds test requirements for the MRCV shaft seal and to check spark rates when spark igniter cables have been disconnected.	Incorporated
R-3825-3 Vol I-107	16 December 1970	Adds torque requirements and applicable MD number change coding for connectors P36 to J36A and P119 to J119A.	Incorporated
R-3825-3 Vol I-108	22 February 1971	Adds requirements to inspect for electrical breakdown path to procedures that attach and detach spark igniter cables to the ECA.	Incorporated
R-3825-3 Vol I-109	2 March 1971	Adds removal and installation procedures and post-installation test requirements for helium control valve filter (MD372).	Incorporated
R-3825-3 Vol I-110	3 March 1971	Updates and adds removal and installation procedures for heat exchanger inlet manifold filter and orifices (MD373 and MD374).	Incorporated
R-3825-3 Vol I-111	22 March 1971	Adds procedure for installing K-seals.	Incorporated
R-3825-3 Vol I-112	30 April 1971	Adds procedure for stripping dye or ink from surfaces that will contact liquid oxygen.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-113	18 June 1971	Adds cautions and warnings relative to isolating and insulating welding cables, and a warning of the existence of high voltages in the welding cables of the Automatic Inert Gas Welding Set G3127.	Incorporated
R-3825-3 Vol I-114	1 July 1971	Changes torque values on pressurizing valve used on ECA, FI package, and spark igniter cables.	Incorporated
R-3825-3 Vol I-115	25 October 1971	Adds procedure for installing heat exchanger inlet manifold filter and orifice on engines incorporating MD375 change.	Incorporated
R-3825-3 Vol I-116	22 October 1971	Adds requirement to use Engine Components Installer G4072MD2 when removing or installing fuel turbopump in an SIVB stage.	Incorporated
R-3825-3 Vol I-117	3 November 1971	Adds procedure for applying thread sealant tape and requirements to perform preinstallation tests when replacing specified components.	Incorporated
R-3825-3 Vol I-118	12 November 1971	Updates removal and installation procedures for oxidizer turbopump to remove and install the oxidizer bleed line and cut and weld redundant instrumentation lines TF1 and NN1.	Incorporated
R-3825-3 Vol I-119	16 November 1971	Revises pressurizing valve removal and installation procedures.	Incorporated
R-3825-3 Vol I-120	22 December 1971	Clarifies start tank vent-and-relief valve removal and installation procedures.	Incorporated
R-3825-3 Vol I-121	10 January 1972	Adds requirement to prevent application of torsional loads to electrical harnesses incorporating bayonet-type electrical connectors and adds a caution to that effect to the removal and installation procedures that involve bayonet-type electrical connectors.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-122	17 January 1972	Adds requirement for replaced vent port check valves to be low-temperature tested and vacuum dried before being returned to stock, and to be low-temperature tested and vacuum dried, and preinstallation tested before being installed.	Incorporated
R-3825-3 Vol I-123	20 January 1972	Adds age control requirements and usability tests for compounds affected by age.	Incorporated
R-3825-3 Vol I-124	19 May 1972	Adds requirement for minimum 1/4-inch gap or insulation between certain parts of the Single Head Special Tool Kit G3127 weld heads and any grounded surface.	Incorporated
R-3825-3 Vol I-125	13 June 1972	Changes low-pressure limit for pressurized gases.	Incorporated
R-3825-3 Vol I-126	26 July 1972	Adds requirement to inspect K-seals for white deposits before installing seals.	Incorporated
R-3825-3 Vol I-127	4 August 1972	Adds maintenance data for engines incorporating a redundant purge check valve, MD383 or MD384 (ECP J2-717).	Incorporated
R-3825-3 Vol I-128	6 November 1972	Adds a procedure for cleaning tarnish from electrical connector pins.	Incorporated
R-3825-3 Vol I-129	20 November 1972	Defines leak test pressures for weld integrity tests.	Incorporated
R-3825-3 Vol I-130	4 April 1973	Adds a maximum limit for tube insertion into end fittings or adapters for in-place tube welding.	Incorporated
R-3825-3 Vol I-131	13 April 1973	Adds warnings for handling specific materials used in the manual.	Incorporated
R-3825-3 Vol I-132	19 June 1973	Adds lubricant grease RB0140-012 (Rocketdyne) as an acceptable material to use on the bell housing packing and attach bolts when connecting spark igniter cables to the ECA.	Incorporated
R-3825-3 Vol I-133	9 November 1973	Adds two additional cleaning solvents that may be used to remove heat sink compound from between thrust chamber temperature transducer and transducer mounting boss.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3825-3 Vol I-134	14 November 1973	Deletes the dimension of the reassed area in the thrust chamber temperature transducer from the procedure for installing thrust chamber jacket temperature transducer.	Incorporated
R-3825-3 Vol I-135	14 March 1974	Deletes requirement for lubricating O-ring on MFV closing control line vent port check valve.	Incorporated
R-3825-3 Vol I-136	18 March 1974	Adds stress corrosion inspection requirements for mainstage OK pressure switches.	Incorporated
R-3825-3 Vol I-137	30 August 1974	Incorporates revised test plate kits which include the necessary attaching hardware.	Incorporated
R-3825-3 Vol I-138	7 January 1975	Adds requirements to inspect weld head side plate covers for loose particles before positioning weld head on engine for in-place welding.	Incorporated